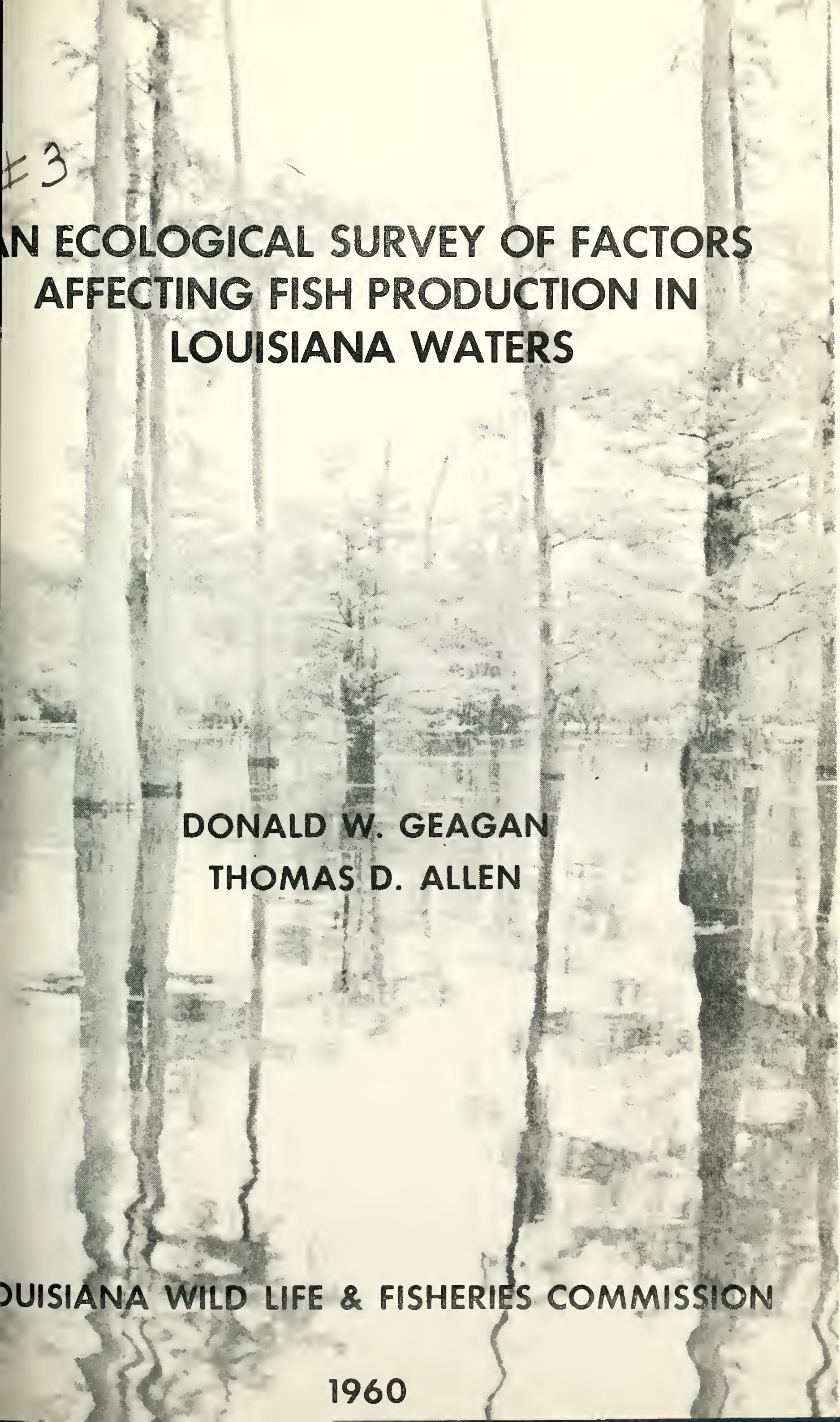

#3

AN ECOLOGICAL SURVEY OF FACTORS AFFECTING FISH PRODUCTION IN LOUISIANA WATERS

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OUISIANA WILD LIFE & FISHERIES COMMISSION

1960

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DINGELL-JOHNSON PROJECT F-6-R LOUISIANA

LOUISIANA WILD LIFE AND FISHERIES
COMMISSION
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1961

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AN ECOLOGICAL SURVEY OF FACTORS AFFECTING FISH PRODUCTION IN LOUISIANA WATERS [1]

Donald W. Geagan [2]

Thomas D. Allen, Jr.[3]

INTRODUCTION

This study was initiated to determine the normal biological, chemical, and physical conditions which are related to fish production for representative lakes in Louisiana. It includes an evaluation of plankton, benthos, and fish population standing crop production plus fish stomach analysis. Pertinent physical and chemical characteristics are also reported. The four lakes studied are Caddo Lake, Caddo Parish; Cane River Lake, Natchitoches Parish; Chicot Lake, Evangeline Parish; and Lake Providence, East Carroll Parish. (Figure 1)

Caddo Lake is a former backwater area of the Red River which was impounded in 1914 by the U. S. Army Engineers. (Figure 2) It is located in the Tertiary uplands 22 miles north of Shreveport, Louisiana. The total surface area is 32,700 acres of which 19,450 acres are located in Marion and Harrison counties, Texas. The water shed surrounding Caddo Lake is considered low in productivity. It contains stands of short leaf pine, Pinus echinata; loblolly pine, P. taeda and hard woods. The lake shore is lined with cypress trees, Taxodium distichum, with stands extending into the lake. The lake's average depth is 6.5 feet. The major portion of the lake consists of open water and exhibits severe wave action under the influence of strong wind.

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[1] Contribution from Dingell-Johnson Project F-6-R, Louisiana.

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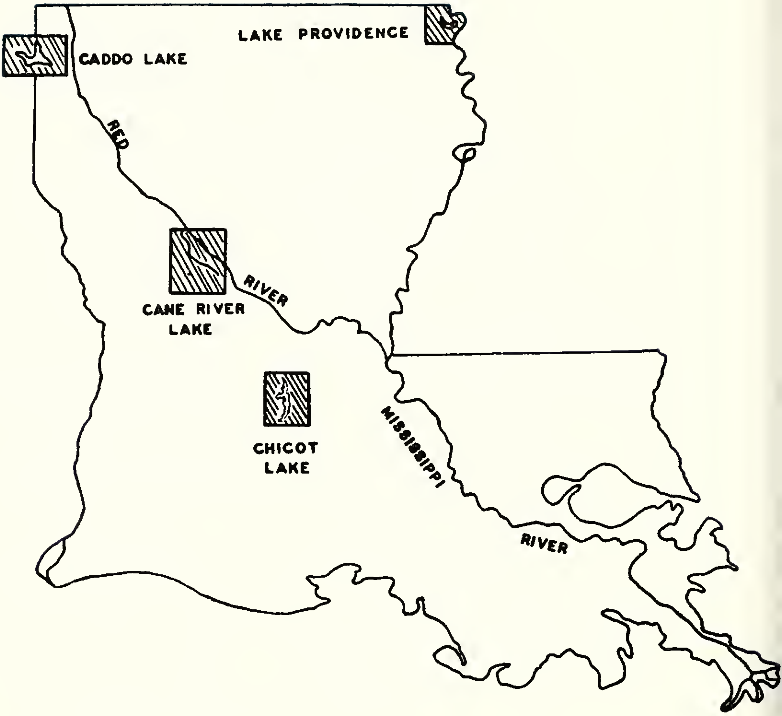


FIG. I. A MAP OF LOUISIANA SHOWING LOCATION OF THE FOUR STUDY LAKES

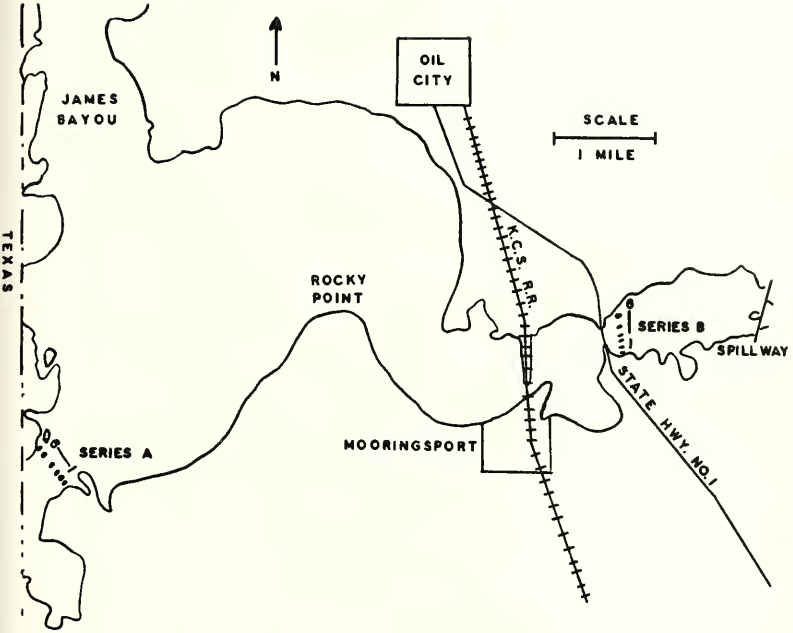


FIG. 2. LAKE CADDO, SHOWING LOCATION OF SERIES AND SAMPLING SITES

Cane River Lake is the original bed of the Red River which was abandoned in 1834 when the river changed its course. (Figure 3 and 4) In 1917, two earthen dams were constructed, one at each end of the former river bed forming a freshwater lake at a constant water level. The surface area of the lake is 1,044 acres with a length of 34.5 miles and an average width of 250 feet. The average depth is 11.5 feet and the maximum depth near the spillway is 25 feet. The lake is situated in the Red River Valley and the water shed consists of soil high in productivity. The lake shore line consists of steep banks on each side, and this factor, with a long narrow configuration, keeps wave action to a minimum.

Chicot Lake was formed by the impoundment of Bayou Chicot in the winter of 1942-1943. (Figure 5) The surface area is 2,000 acres. The lake's average depth is 6 feet and it contains stands of cypress; tupelo gum, Nyssa aquatica; button bush, Cephalanthus occidentalis; and black willow, Salix nigra, throughout the lake. The presence of these trees along with numerous dead stumps and high, heavily wooded banks keeps wave action to a minimum. The lake also has a very serious aquatic vegetation problem consisting primarily of Elodea sp., Cabomba caroliniana, and Myriophyllum sp. Chicot Lake undergoes annual water level fluctuation for the purpose of controlling the aquatic vegetation. This fluctuation normally takes place from mid-summer until the first of the following year. During this period no sampling was conducted on this lake.

Lake Providence is a Mississippi River ox-bow and is located in the Mississippi River alluvial plain. (Figure 6) The surrounding water shed is high in productivity. The lake's basin is long and narrow with a maximum length of 5.5 miles and an average width of 1.3 miles. The surface area is 1,380 acres and the maximum depth is 40.25 feet; the average depth is 11.5 feet. The shore is lined with cypress trees, but due to the width and length, wave action is considerable under the influence of strong wind.

SAMPLING PROCEDURE

Each lake was sub-divided into two series consisting of six samples each. The two series for each lake were run from bank to bank across representative portions of the lakes. From each of the six samples in each series, benthos samples were collected quarterly over the three year study period. From one of the middle stations in each of the series, monthly samples were collected for net and nanno plankton

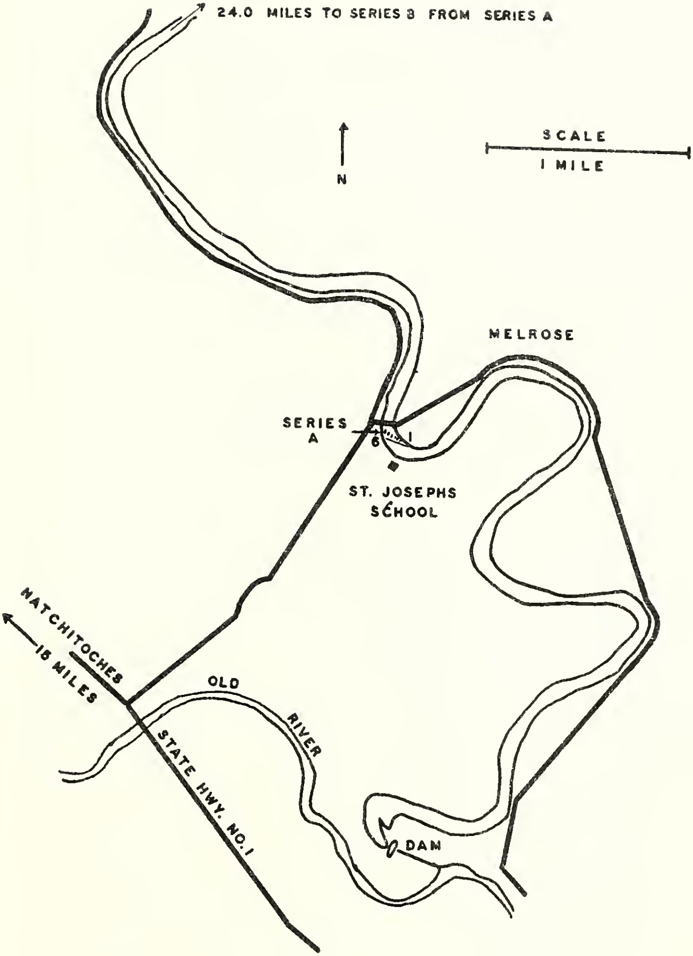


FIG. 3. CANE RIVER LAKE, SHOWING LOCATION OF SERIES A SAMPLING SITES

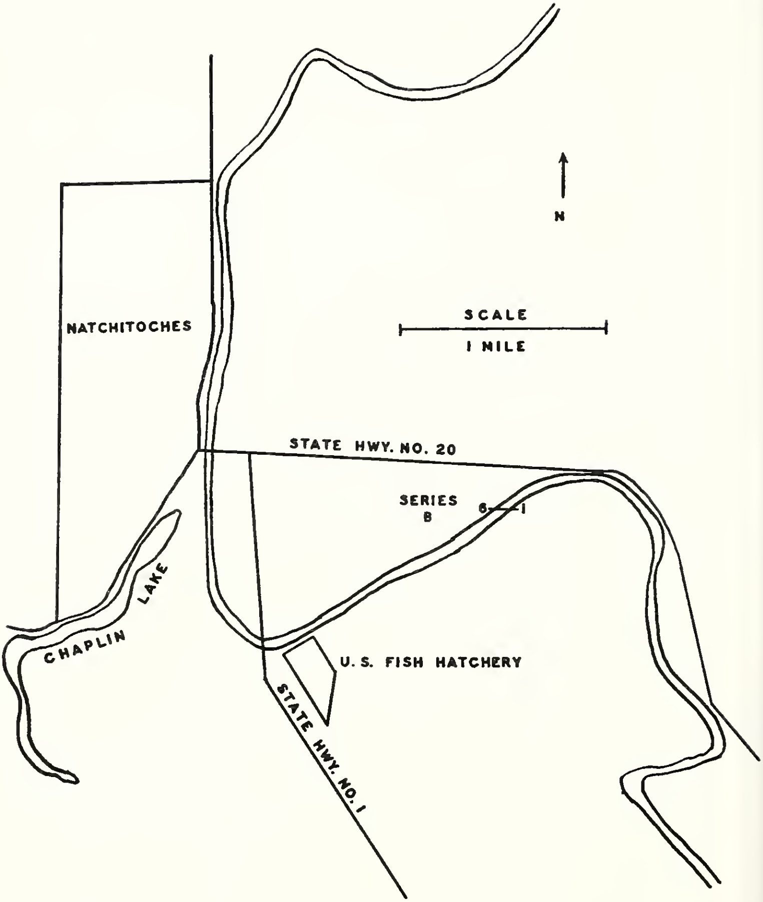


FIG. 4. CANE RIVER LAKE SHOWING LOCATION OF SERIES B SAMPLING SITES

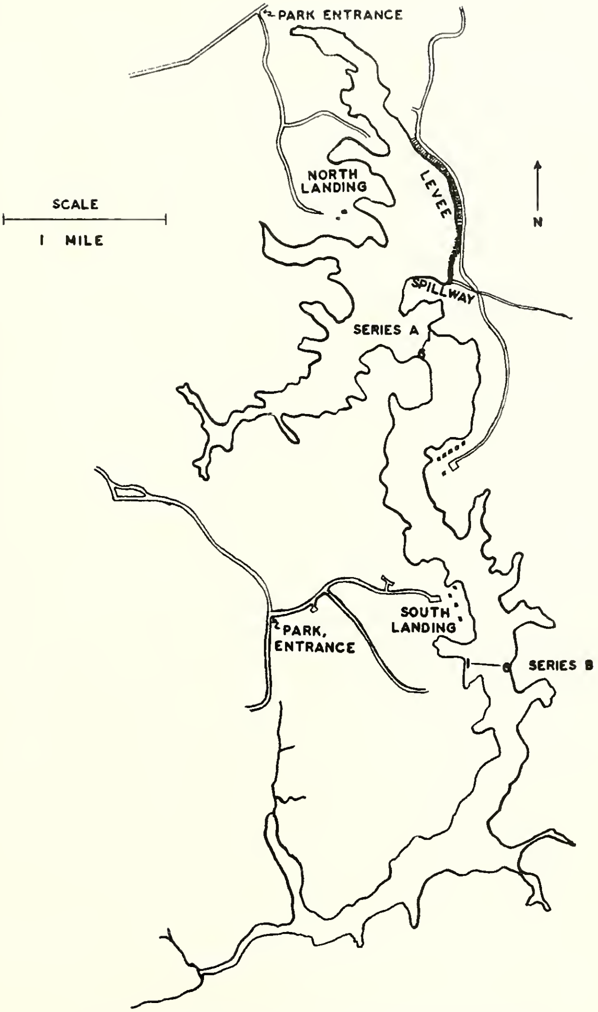


FIG. 5. LAKE CHICOT, SHOWING LOCATION OF SERIES AND SAMPLING SITES

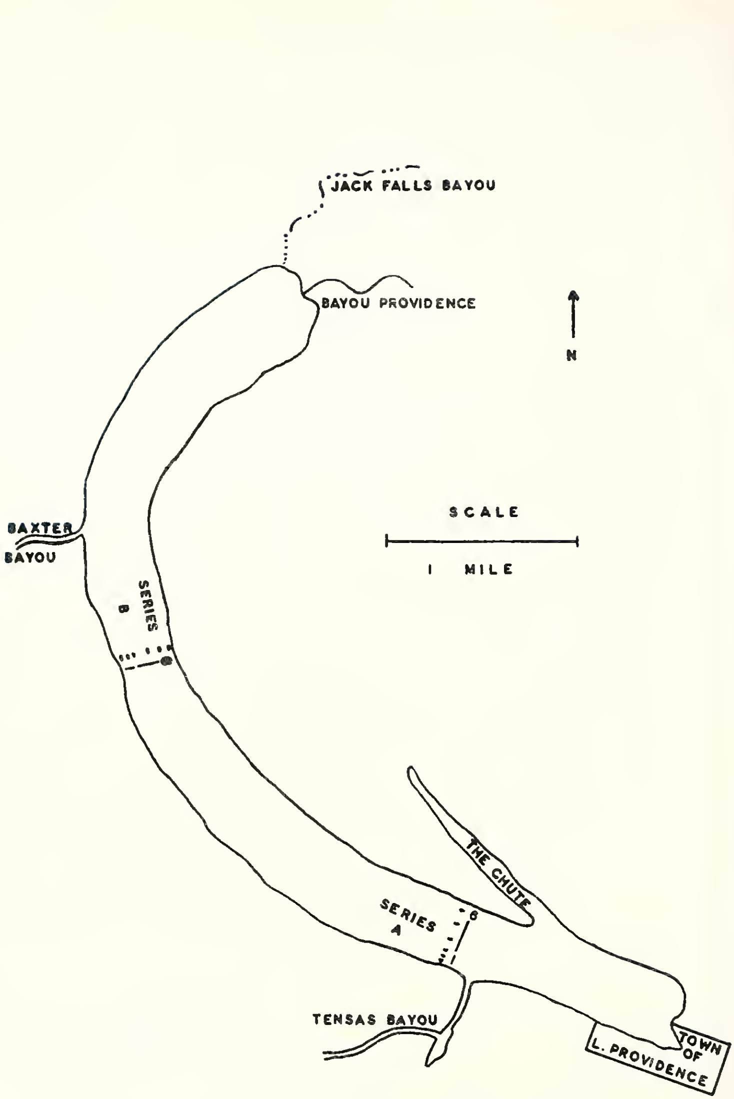


FIG. 6. LAKE PROVIDENCE, SHOWING LOCATION OF SERIES AND SAMPLING SITES

along with water samples for laboratory analyses. At the same time these samples were collected, field analyses were conducted for water temperature, dissolved oxygen, carbon dioxide, alkalinity, and pH. Secchi disc readings were also made. The sampling period was originally planned to be the last week of each month. However, due to various interferring factors, this sampling schedule frequently lapsed into the first week of the following month; as a whole, the sampling schedule averaged monthly intervals.

CHEMICAL AND PHYSICAL PROCEDURES

Water samples for field analyses were collected at depths of 3 feet with a Sewage water sampler. Field analyses included free carbon dioxide determined by titration with 1/44 N sodium hydroxide, dissolved oxygen analysis using the unmodified Winkler method, carbonate and bicarbonate alkalinity analyses by titration with a 0.02 N sulfuric acid. A Hellige pH color comparator was used for pH determinations. Water temperatures were recorded with the use of a reversing thermometer or with an electrical resistance thermometer.

Samples collected for laboratory analyses were taken at depths of 3 feet with a portable power pump. These samples were then frozen with dry ice and returned to the New Orleans laboratory. Laboratory analyses included colorimeteric determinations conducted for the first two years of the study with a Cenco photolometer using 5 centimeter cells and during the last year with a Bauch and Lomb Spectronic "20" colorimeter. These analyses included total and available phosphates, organic nitrogen, ammonia nitrogen, nitrate nitrogen, and nitrite nitrogen. Turbidity evaluations were made with a Jackson turbidimeter. Water color determinations were made with a Taylor color comparator.

PHYSICAL CHARACTERISTICS

All four lakes showed a decline in water color in the early spring of each year with the exception of Chicot Lake in 1958. Chicot Lake, with a mean water color for the three year period of 32, consistantly had an annual mean water color higher than any of the three other lakes. Lake Providence had the lowest annual mean color readings with a mean of 18.9 for the entire study period. Lake Providence exhibited the most stable condition with regards to variation in the intensity of color. Cane River Lake and Caddo Lake were very similar in their study period means, 22.2 and 23.5 respectively, and both showed similarity in seasonal trends.

Turbidity for all four lakes was under 25 parts per million for the entire study. Since the Jackson turbidimeter which was used was incapable for determining lower readings, no figures are given.

Figures 7 through 14 show the surface and bottom temperatures from the two sampling stations in each lake. Cane River Lake recorded the highest temperature during the study in July 1959 with a reading of 33.5°C. Caddo Lake was consistently lowest with a low of 4.81°C in November 1958. The winter period of 1959-1960 exhibits the longest period of low temperatures during the study. Whereas the low temperature winter period lasted during three months of sampling in 1957-58 and 1958-59, for the winter of 1959-60 this low temperature winter period occurred for five months for the surface temperatures and six months for the bottom temperatures in all lakes except Caddo Lake.

Evidence of thermal stratification was seen in all lakes except Caddo Lake. Chicot Lake was checked for bottom to surface temperatures at both stations on June 24, 1958. The results of this are shown in Figure 15. From this illustration it may be noted that this stratification does not fit the normal picture of an epilimnion, thermocline, and hypolimnion. There is a decline in temperature from top to bottom causing the entire picture to resemble a thermocline according to Birge's definition as given in Welch (1952). Moore (1952), who first reported stratification in Chicot Lake, found that in some cases the temperature of the epilimnetic zone was uniform, but that there was rarely any discernable hypolimnion; the thermocline extending to the lake bottom. Similar cases were reported by Sublette (1955) in shallow areas of Lake Texoma and by Wallen (1950) in shallow ponds in Eastern Oklahoma. Some questions arise as to the stability of this thermal stratification as Moore (1952) reported that it was upset temporarily during his observation.

Moore (1952) explains this condition of thermal stratification on the basis of a narrow configuration of the lake along with the steep, heavily wooded shores. These factors would minimize any circulating effects of wind action. Another factor which probably minimizes circulation is the heavy growth of aquatic vegetation infesting the lake. (Figure 16)

Surface to bottom temperatures were recorded in Lake Providence and these showed a thermal stratification occurring each summer during the study. Figure 17 illustrates these results. Stratification occurs between April and June and the period of circulation has begun

FIG. 7. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE CADDO. SERIES A.

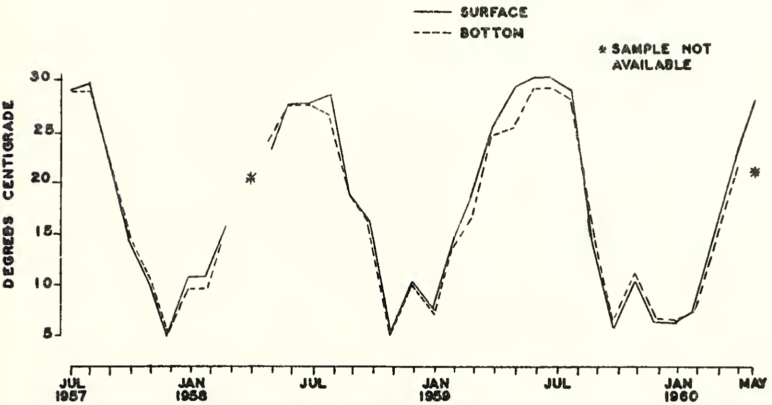


FIG. 8. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE CADDO. SERIES B.

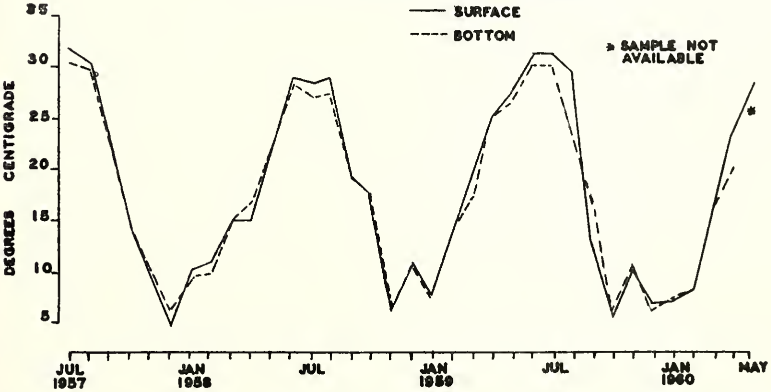


FIG. 9. SURFACE & BOTTOM TEMPERATURES OCCURRING IN CANE RIVER LAKE, SERIES A.

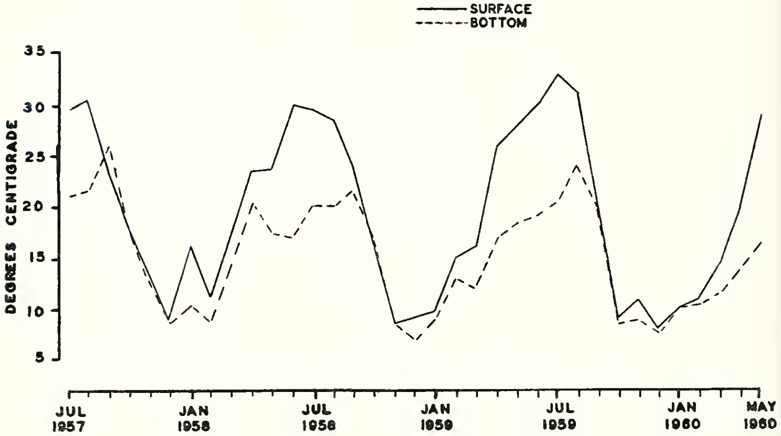


FIG. 10. SURFACE & BOTTOM TEMPERATURES OCCURRING IN CANE RIVER LAKE, SERIES B.

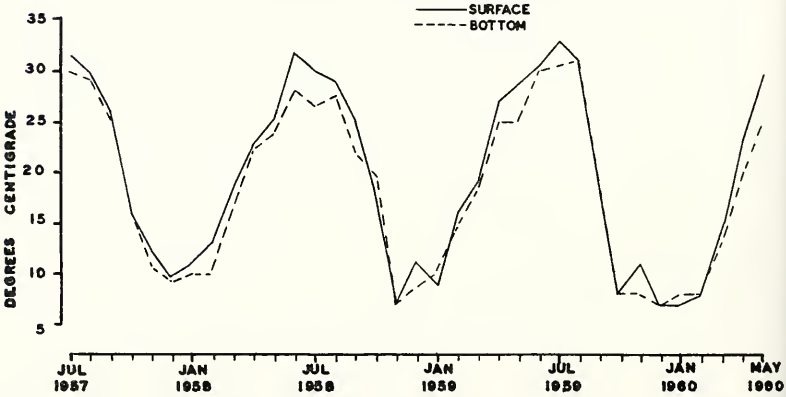


FIG. 11. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE CHICOT, SERIES A.

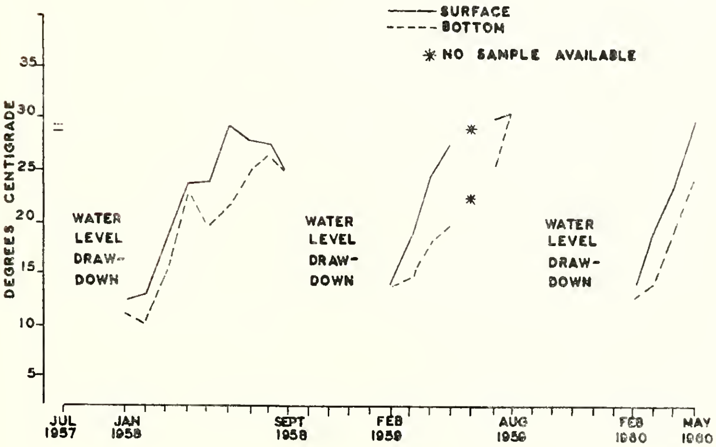


FIG. 12. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE CHICOT, SERIES B.

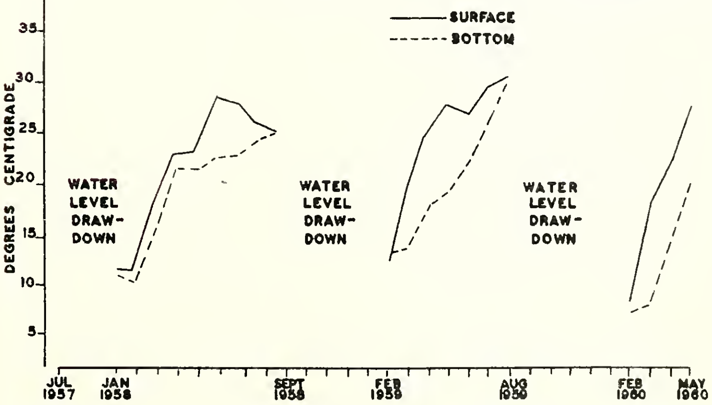


FIG. 13. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE PROVIDENCE, SERIES A.

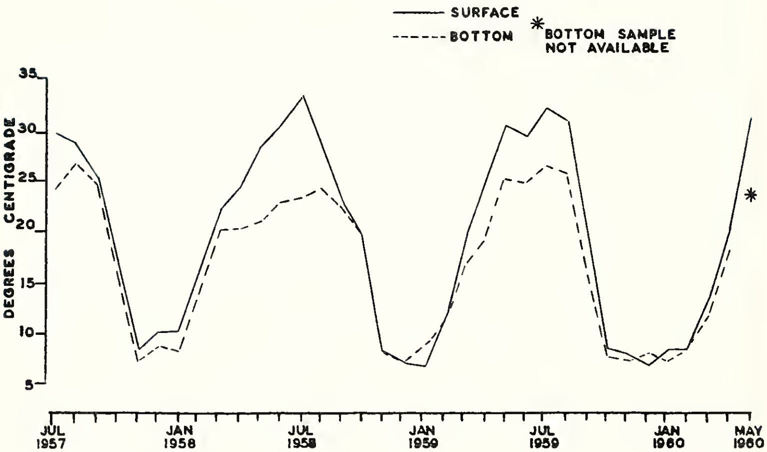


FIG. 14. SURFACE & BOTTOM TEMPERATURES OCCURRING IN LAKE PROVIDENCE, SERIES B.

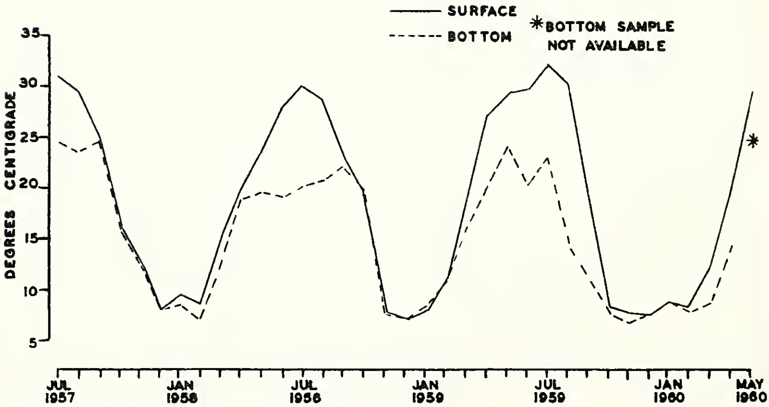


FIG. 15. THERMAL STRATIFICATION OCCURRING IN LAKE CHICOT RECORDED ON JUNE 24, 1958

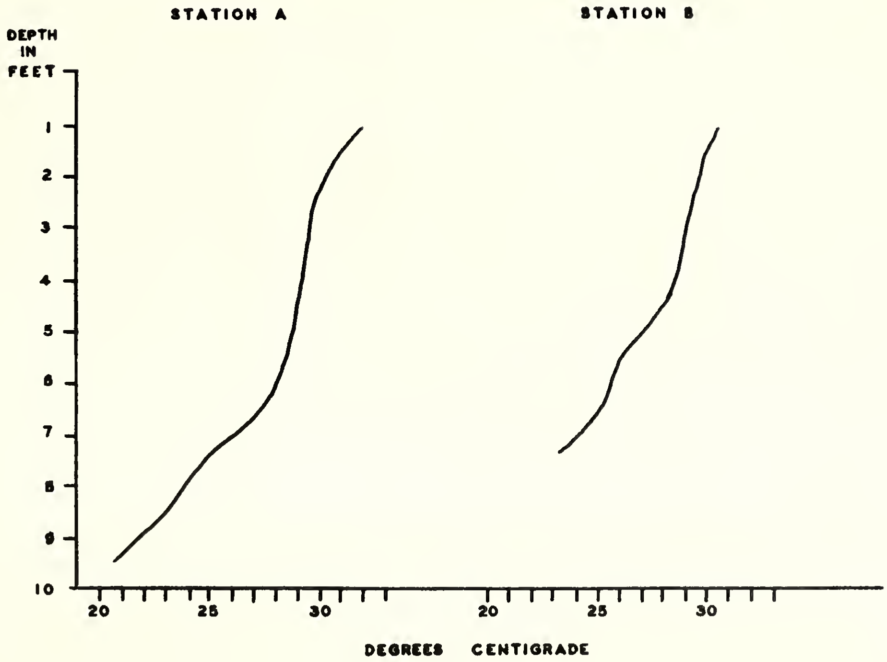
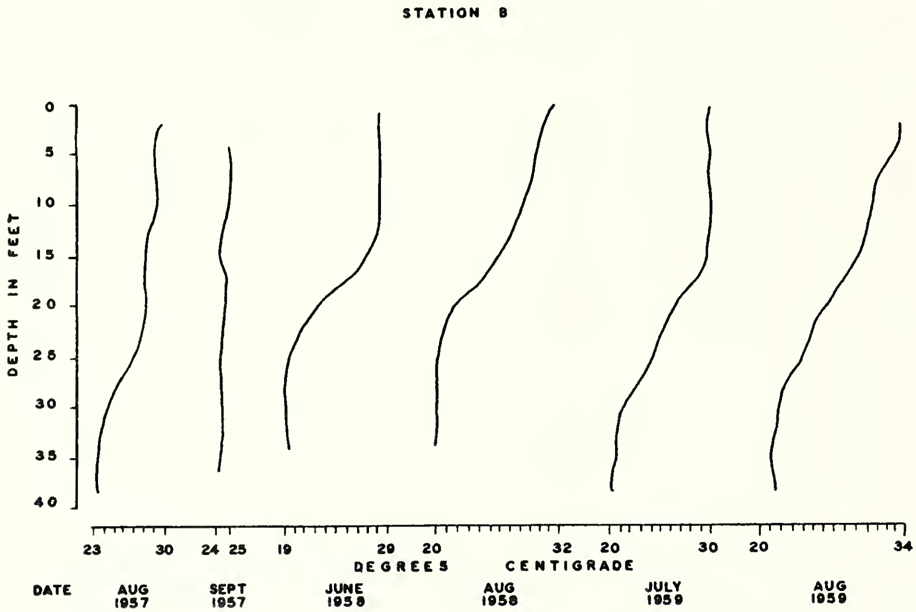


FIG. 17 THERMAL STRATIFICATION OCCURRING IN LAKE PROVIDENCE DURING THE SUMMERS OF 1957, 1958, & 1959.



by the end of September. The depth of the epilimnion apparently varies considerably as it was found to be 14 feet in June 1958 and 23 feet in August 1957. Moore (1946) at no time reports the epilimnion to extend below 16 feet. In both August 1958 and 1959, the stratification took on the characteristic of having the thermocline extend completely to the surface. This would seem to indicate that during these periods circulation was minimized. Moore (1946) does not report any such occurrence during his study of this lake.

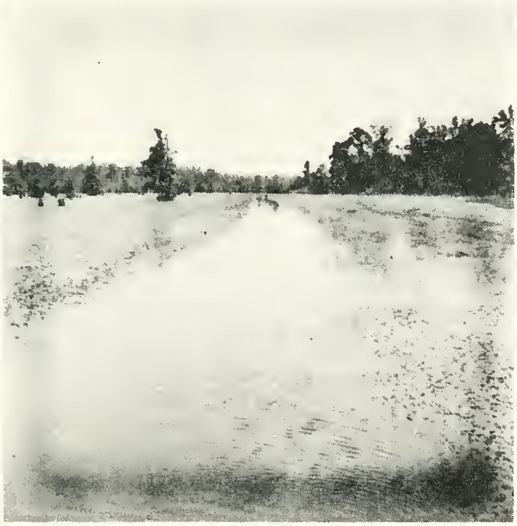


Figure 16. View of Chicot Lake illustrating the dense growth of **Elodea sp.** Note the boat road which is the only passable area with an outboard motor.

The characteristics of the stratification in Lake Providence meet all the requirements of a summer thermal stratification; that is, having an epilimnion, thermocline, and hypolimnion. This stratification is apparently able to develop due to the depth of the lake as wind and wave action are considerable.

Lake Providence does not adequately fit the classification of Forel-Whipple, according to Welch (1952), for stratified lakes but must be considered as an intergrade between the second and third order of the tropical types according to this system. This lake does more closely fit the classification provided by Yoshimura which was listed by Hutchinson (1957). This classification lists tropical, sub-tropical, temperate, sub-polar and polar categories. Lake Providence fits most adequately the sub-tropical category which is defined as follows: lakes with the surface temperature never below 4°C, annual variation large, thermal gradient large, and one circulation period in the winter.

Cane River Lake at Series B showed no indication of thermal stratification; however, this station was only 10 feet deep. At series A there was evidence of stratification each summer. This condition was probably due to the depth (averaged over 20 feet), narrow basin, and the steep banks. The differences in surface and bottom temperatures for this series were 8.5°C, July 1957; 13°C, June 1958; 10.9°C, June 1959; and 10.5°C, May 1960. Surface to bottom temperatures were not recorded for this lake.

Caddo Lake, as previously stated, showed no evidence of thermal stratification during the entire study and, in general, the surface and bottom temperatures were close. This lack of stratification is probably due to the extensive open water areas and the shallow depth of the lake.

Secchi disc readings were low for all four lakes. Welch (1952) presents data of Birge and Juday (1930) stating that Secchi disc readings of 1.4 meters (4.6 feet) - 2.9 meters (9.5 feet) indicates low total light penetration. Chicot Lake had the highest mean project Secchi disc reading and this was only 2.76 feet. The highest individual reading was 6 feet, also from Chicot Lake at Series B in June 1958. Chicot Lake showed the greatest variation in light penetration with the highest readings occurring each year in June after cessation of the spring rains and prior to the turbid condition of the water which occurs in late summer from organic materials in the stands of aquatic vegetation.

Cane River Lake showed the lowest average Secchi disc reading of 1.99 feet for the four lakes during the study period. However, Caddo Lake was very close with a three year average of 2.04 feet. Secchi disc readings were recorded in 0.5 foot depths only, the above figures to the second decimal place are the results of averaging.

CHEMICAL CHARACTERISTICS

Lake Providence had the highest average dissolved oxygen content with a mean of 10.16 ppm and a mean percent saturation for dissolved oxygen of 104.52%. This lake also showed the highest individual dissolved oxygen reading. This was 17.5 ppm in January 1960. In May 1960, the highest percent saturation recording (190%) was also from Lake Providence. Moore (1950) recorded a high of 18.85 ppm dissolved oxygen and 245% saturation for this lake. Figures 18 and 19 illustrate the monthly dissolved oxygen determination. It may be noted that in general two seasonal peaks are displayed. A more prominent peak for late fall, winter, and early spring with a lesser peak in mid-summer.

The early fall drop in dissolved oxygen would normally be attributed to the fall turnover or period of circulation. This would cause the waters of the hypolimnion to come to the surface with a high organic content and an absence of dissolved oxygen which developed through the period of summer stratification. However, the low for dissolved oxygen, both in content and percent saturation, in 1958 occurs in the August sampling. (Figures 18 and 19) This sample was actually taken on September 11, 1958 and at that time the lake still showed a well defined thermal stratification. (Figure 17)

Cane River Lake also shows the dissolved oxygen and percent saturation to be greatest during the late fall, winter and early spring period with a decline in late summer or early fall, in 1958 and 1959. (Figures 20 and 21) This decline is similar to the one Lake Providence had in mid or late spring. (Figures 18 and 19) Another interesting characteristic which was noted in mid-summer in both lakes (Cane River Lake and Lake Providence) was a rise in dissolved oxygen. Sublette (1957) reported a low of 0.8 ppm at Chaplin's Lake in June. This lake is adjacent to Cane River Lake and is very similar. No reading was noted in Cane River Lake at any period lower than 2.5 ppm which was 27% saturated as recorded in October 1958. The variation between the two sampling stations was greater in Cane River Lake than that noted in Lake Providence. This could be attributed to the difference in the lakes' two stations. This difference was a greater depth at Series A (over 20 feet) with much higher and steeper banks than at Series B (10 foot depth).

The results from the two series sampling stations in Caddo Lake were fairly similar throughout the study. (Figure 22 and 23)

FIG. 18. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM LAKE PROVIDENCE

JULY 1957–MAY 1960
SERIES A

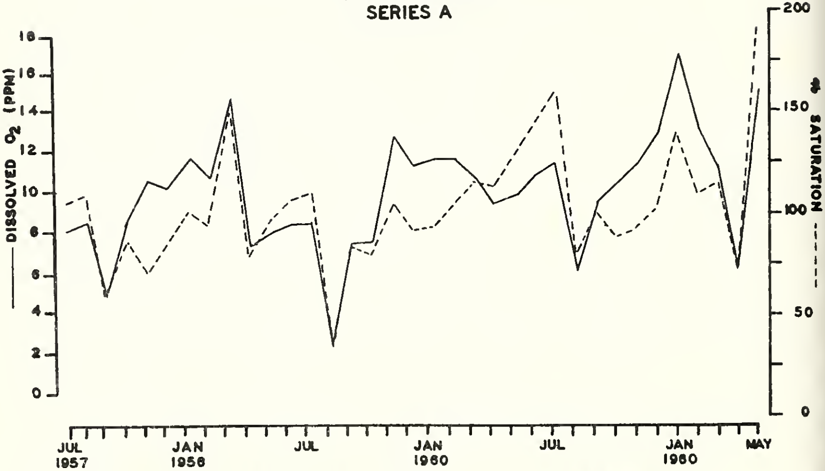


FIG. 19. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM LAKE PROVIDENCE

JULY 1957–MAY 1960
SERIES B

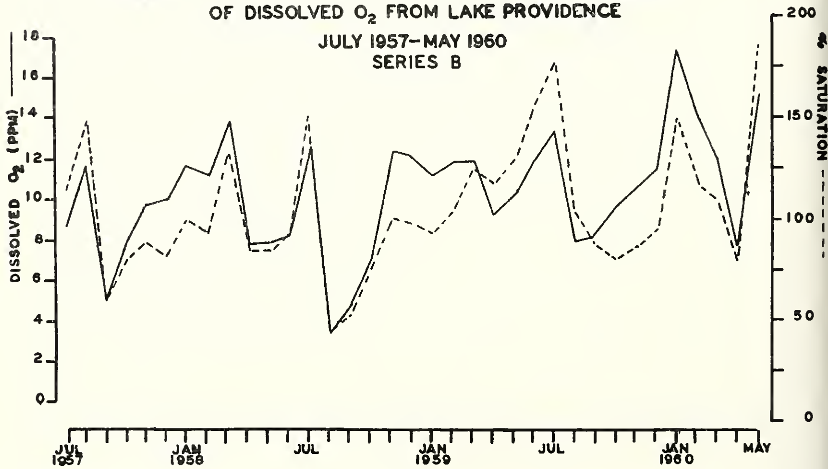


FIG. 20. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM CANE RIVER LAKE

JULY 1957–MAY 1960

SERIES A

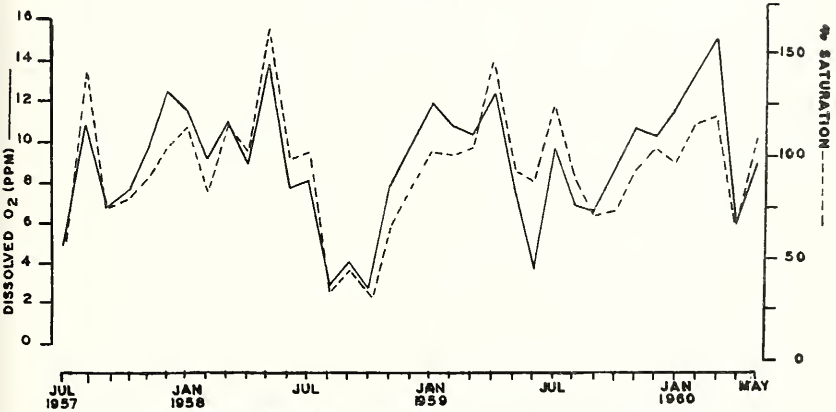
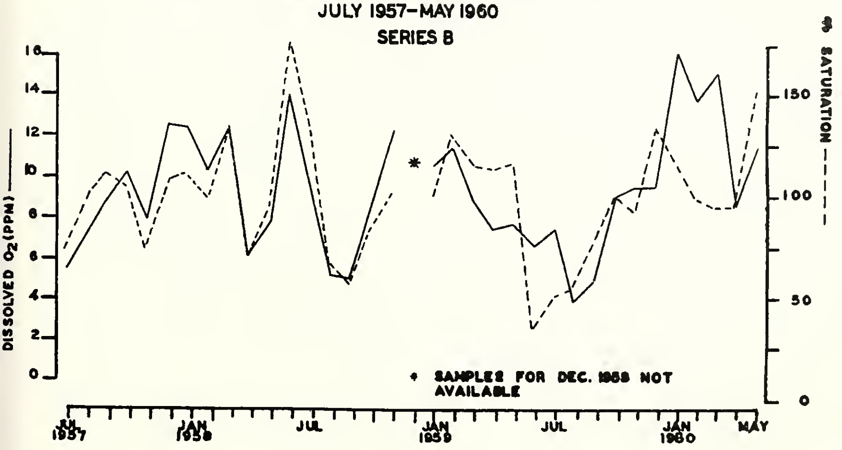


FIG. 21. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM CANE RIVER LAKE

JULY 1957–MAY 1960

SERIES B



* SAMPLES FOR DEC. 1958 NOT AVAILABLE

FIG. 22. A COMPARISON OF DISSOLVED O_2 & % SATURATION
OF DISSOLVED O_2 FROM LAKE CADDO
JULY 1957–MAY 1960
SERIES A

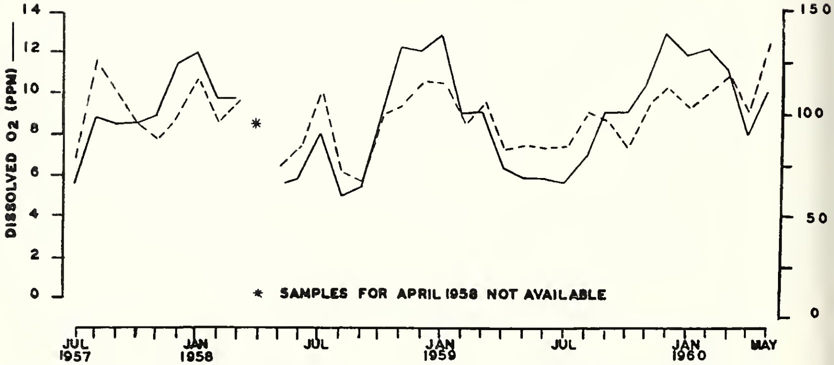
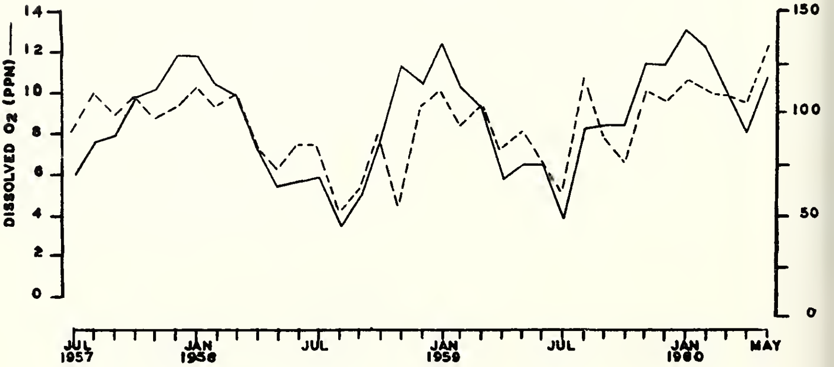


FIG. 23. A COMPARISON OF DISSOLVED O_2 & % SATURATION
OF DISSOLVED O_2 FROM LAKE CADDO
JULY 1957–MAY 1960
SERIES B



The seasonal dissolved oxygen fluctuations followed a high during the winter months and low during the summer. There was a slight drop in the dissolved oxygen in the late summer of 1958 and 1959; however, this was by no means as pronounced as was observed in Cane River Lake (Figures 20 and 21) and in Lake Providence (Figures 18 and 19). The dissolved oxygen when presented in terms of percent saturation showed much less seasonal variation than was noted in Lake Providence and Caddo Lake. This could be due to the shallow depth of the lake along with the extensive open water areas which permit adequate circulation.

Chicot Lake presented a picture of low dissolved oxygen determinations just prior to water level draw-down and immediately after the water level was raised. (Figures 24 and 25) The exception to the latter part of this statement was the high D. O. in January 1958 following the return of the lake's water level to spillway height. The low dissolved oxygen content in the summer prior to draw-down was probably due to poor water circulation and dense stands of aquatic vegetation. Stands of aquatic vegetation are usually associated with higher D. O., but the condition of Chicot Lake was such that by late summer the growth had become extremely dense and large quantities of decaying vegetation were noted. Bacterial action associated with this decomposition, along with respiration from plants too shaded by the dense condition of the growth to produce oxygen by photosynthesis, possibly were responsible for the low dissolved oxygen content.

The low reading in 1959 and 1960 prior to the return of the water level to normal may be accounted for when it is considered that the decomposing vegetation which had been exposed throughout the draw-down period was inundated. This in turn placed a demand on the dissolved oxygen content of the lake's waters.

In general it may be said that throughout the study the dissolved oxygen content of all four lakes was adequate to support the aquatic organisms.

Carbon dioxide as determined by titration showed no discernable seasonal trends for Caddo Lake. In fact, little correlation can be made between results obtained at the two stations. (Figures 26 and 27) The only factor in common between these results was the presence of carbon dioxide at both stations at all times throughout the study.

The carbon dioxide content for Cane River Lake was also found to be very erratic with little or no seasonal trends. (Figures 28 and 29) There were periods in the spring of each year when no carbon dioxide was present, along with one period in late summer of 1957.

FIG. 24. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM LAKE CHICOT.

JULY 1957–MAY 1960

SERIES A

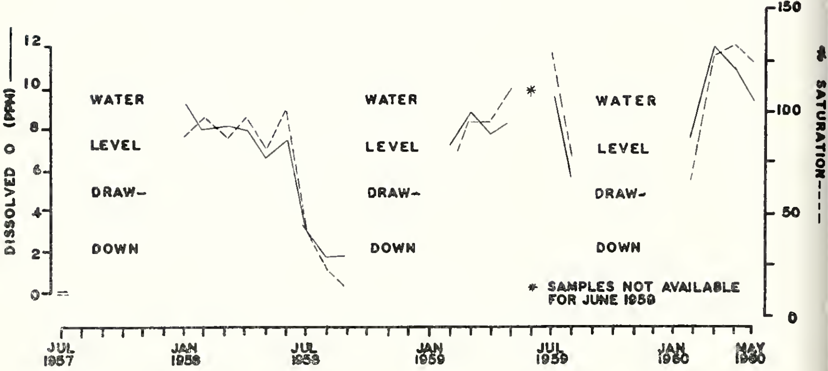


FIG. 25. A COMPARISON OF DISSOLVED O_2 & % SATURATION OF DISSOLVED O_2 FROM LAKE CHICOT.

JULY 1957–MAY 1960

SERIES B

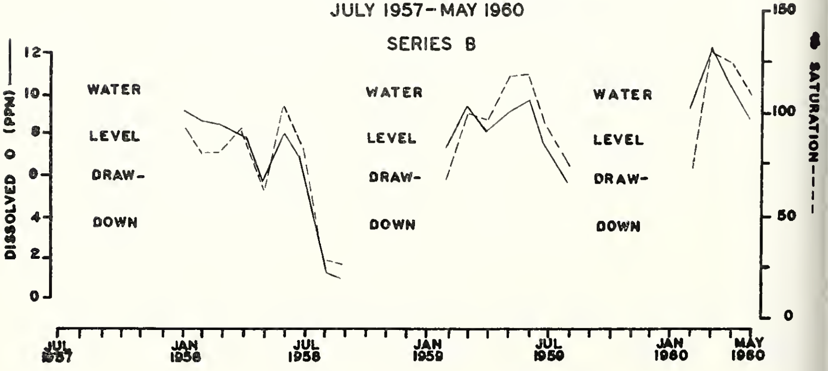


FIG. 26. A COMPARISON OF FREE CO_2 TO pH FROM LAKE CADDO FROM JULY 1957 TO MAY 1960

SERIES A

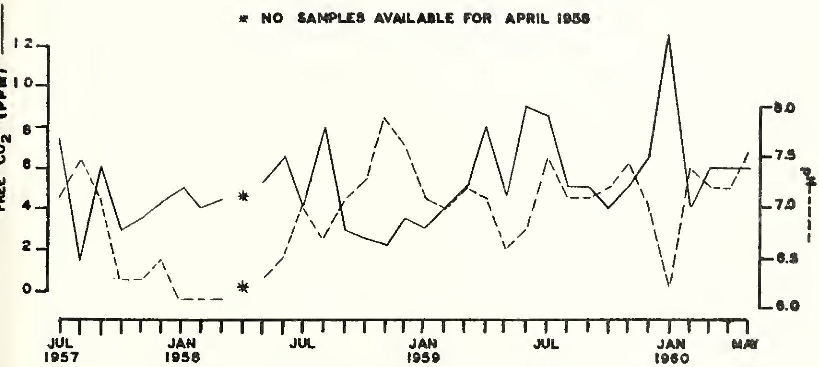


FIG. 27. A COMPARISON OF FREE CO_2 TO pH FROM LAKE CADDO FROM JULY 1957 TO MAY 1960

SERIES B

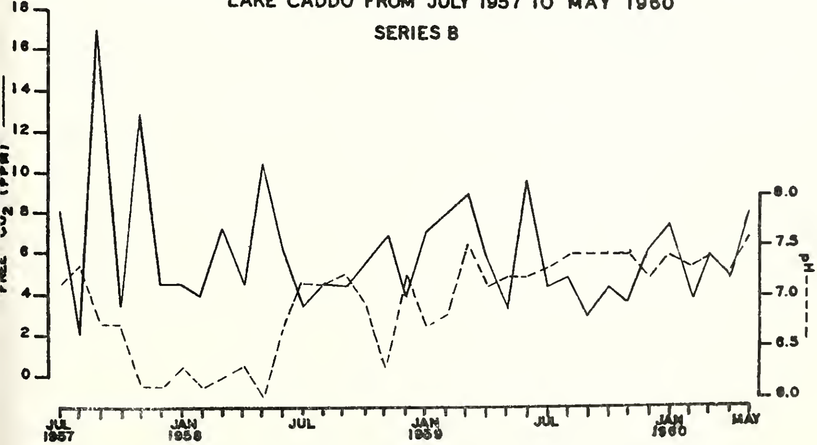


FIG. 28. A COMPARISON OF FREE CO2 TO pH FROM CANE RIVER LAKE FROM JULY 1957 TO MAY 1960

SERIES A

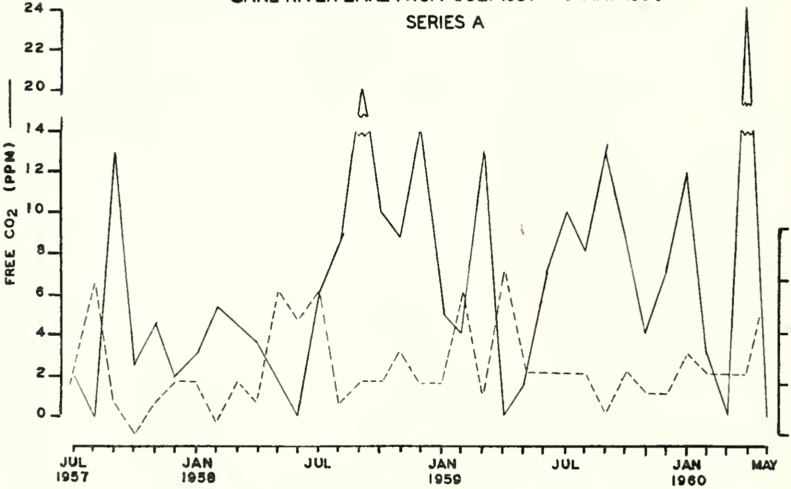
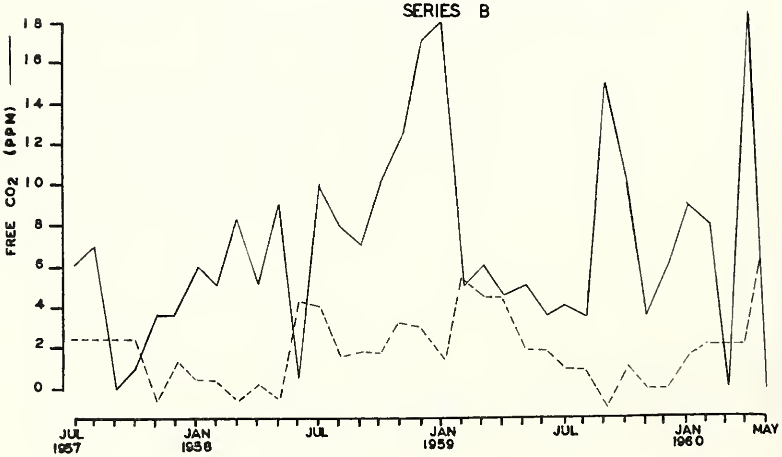


FIG. 29. A COMPARISON OF FREE CO2 TO pH FROM CANE RIVER LAKE FROM JULY 1957 TO MAY 1960

SERIES B



Considerable variations were noted between the two sampling stations as in Caddo Lake. Also, the carbon dioxide content at Series A in general was found to run in an inverse proportion to the dissolved oxygen content. This characteristic was by no means as evident in Series B.

In Chicot Lake the carbon dioxide results from the two series followed similar trends with the exception of August 1959. (Figures 30 and 31) There were at times, considerable differences in the quantities of carbon dioxide at the two sampling stations. No consistency was noted in seasonal trends in the lake with the exception of a lack of free carbon dioxide in Series B samples each spring.

The results of carbon dioxide from the two series samples in Lake Providence more closely resembled one another than any other of the study lakes with Series A (Figure 32) having a slightly higher three year average than Series B. (Figure 33) As was noted in Series A in Cane River Lake, the dissolved oxygen and carbon dioxide contents generally were present in quantities inverse to one another. No carbon dioxide was present during at least one period of the spring each year. This lack of carbon dioxide was also noted in late summer each year, with the exception of Series A during 1958.

The longest period in which carbon dioxide was noted was the period following the initiation of the fall circulation. At this time, carbon dioxide would always reappear at both stations, but following this appearance the quantity present during the winter was erratic from year to year.

Caddo Lake showed no carbonate alkalinity for any of the study period. (Figure 34) The highest bicarbonate alkalinity result was recorded in May 1959 (45 ppm) while the lowest was a reading of 7 ppm in January 1960. The average for the study period was 21.34 ppm. The results were erratic with practically no seasonal trends noted.

Cane River Lake had a mean bicarbonate alkalinity of 150.31 ppm for the study period with a high of 295 ppm in June 1959 at Series B. The lowest reading was 76.5 ppm in August 1957, in Series A. Considerable differences were shown in the results from the two sampling sites. (Figure 35) Averages from Series B for the first two years were much higher in bicarbonate content than in Series A.

However, in the last year of the project little difference was seen in the averages, but the individual recordings vary with opposite trends

FIG. 30. A COMPARISON OF FREE CO_2 TO pH FROM LAKE CHICOT FROM JULY 1957 TO MAY 1960

SERIES A

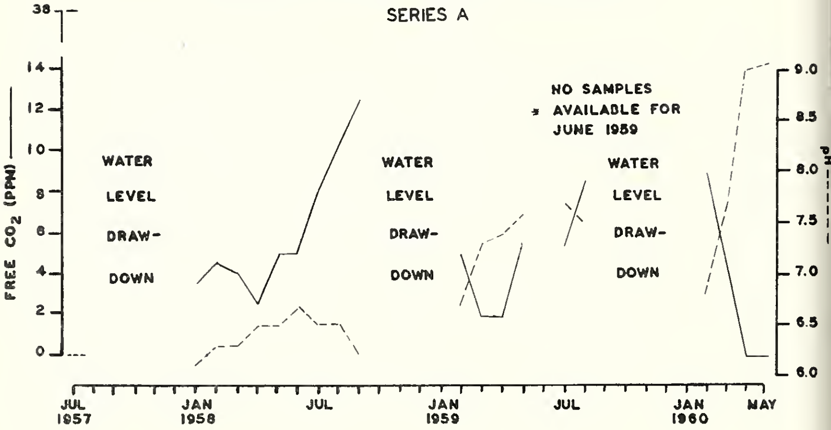


FIG. 31. A COMPARISON OF FREE CO_2 TO pH FROM LAKE CHICOT FROM JULY 1957 TO MAY 1960

SERIES B

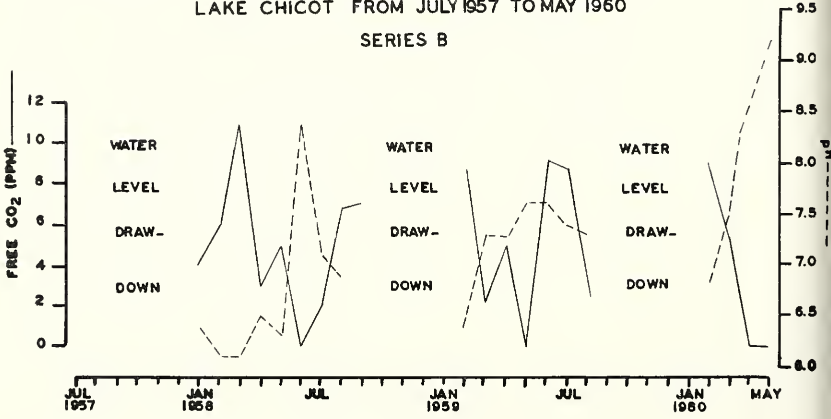


FIG. 32. A COMPARISON OF FREE CO_2 TO pH FROM LAKE PROVIDENCE FROM JULY 1957 TO MAY 1960

SERIES A

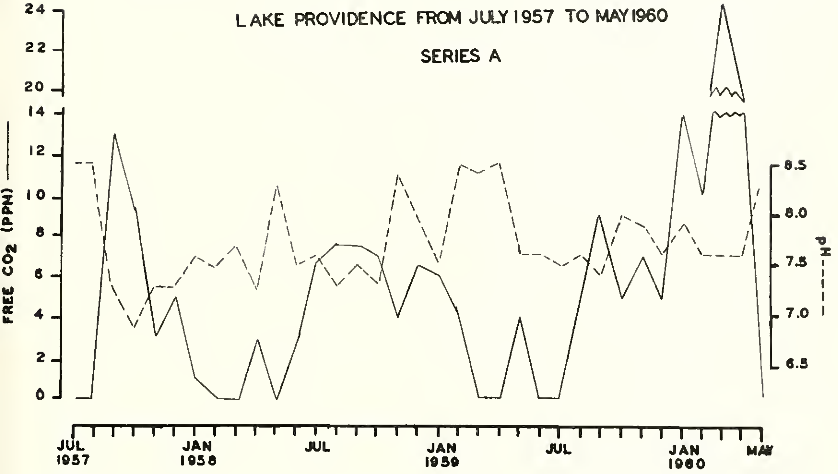


FIG. 33. A COMPARISON OF FREE CO_2 TO pH FROM LAKE PROVIDENCE FROM JULY 1957 TO MAY 1960

SERIES B

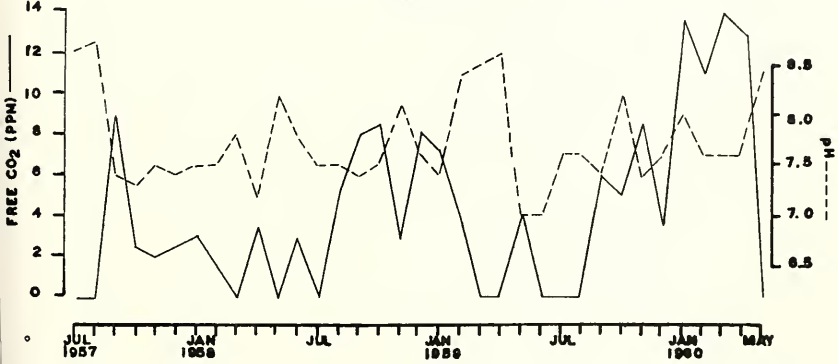


FIG. 34. A COMPARISON OF CARBONATE & BICARBONATE ALKALINITY IN LAKE CADDO FROM JULY 1957 TO MAY 1960.

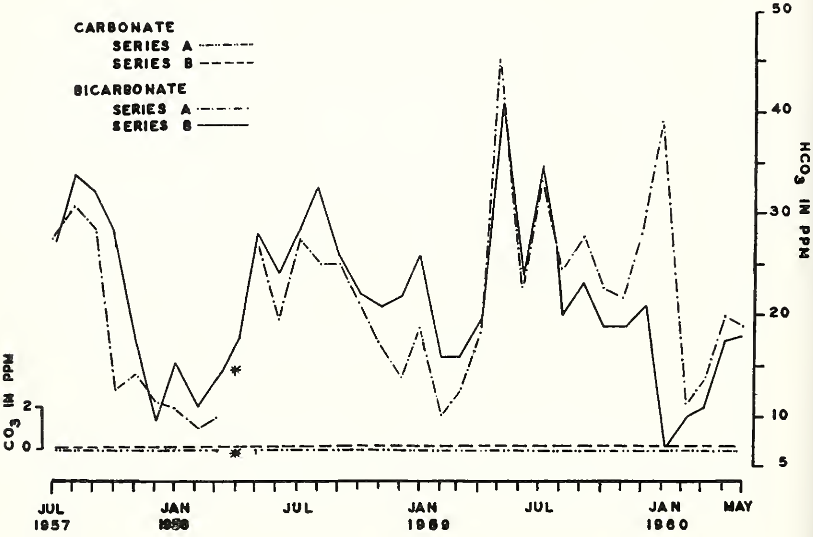
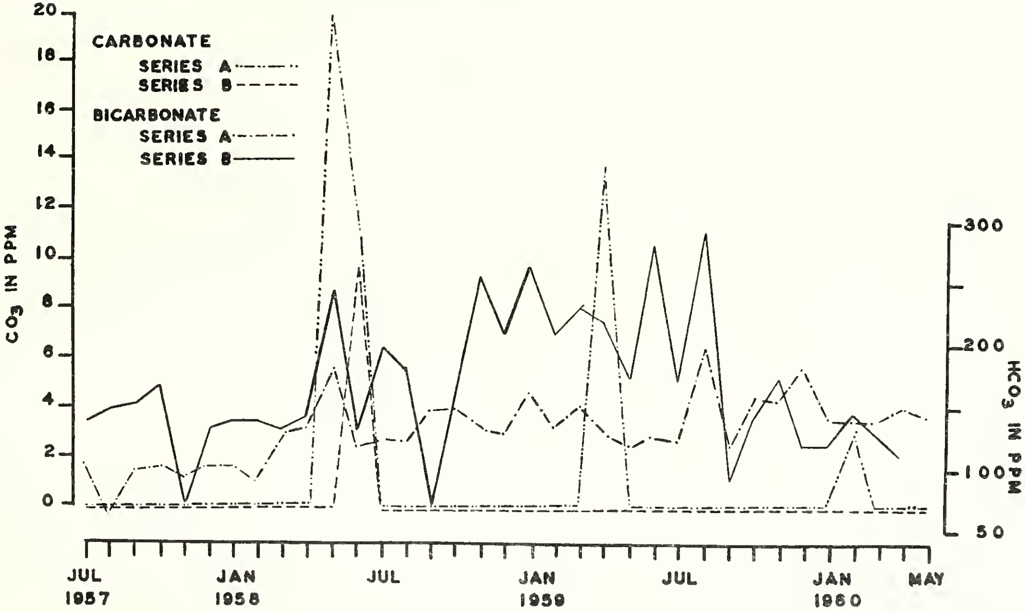


FIG. 35. A COMPARISON OF CARBONATE & BICARBONATE ALKALINITY IN CANE RIVER LAKE FROM JULY 1957 TO MAY 1960



being noted at times. This difference in results is probably due to the vast distance between the two stations along with depth and bank configuration variations. Variations were also found in the carbonate alkalinity between the two sampling sites. However, here the picture was opposite from that presented with the bicarbonate alkalinity in that Series A consistently presented a higher carbonate production. In Series B, carbonate alkalinity was recorded only in June 1958.

Bicarbonate alkalinity in Chicot Lake showed an erratic rise following return of the water level to spillway height, the peak occurring either in the late spring or early summer. (Figure 36). Then there was a decline which continued until the water level was lowered the following fall. The bicarbonate content at times differred considerably between stations, although trends were in the same direction. The highest recording, 42 ppm, was made at Series B in July 1958. The lowest was 7 ppm in April 1960 at Series A. Carbonate alkalinity was recorded each year in the spring at Series B, but only in April 1960 at Series A. The highest carbonate recording was 8 ppm.

Lake Providence had the second highest bicarbonate alkalinity and the highest carbonate alkalinity. (Figure 37) The bicarbonate content at the two sampling sites was more similar in this lake throughout the study than in any other. Also noted was a general seasonal trend with a low in late summer or early fall and a gradual subsequent rise to a peak in the following winter or spring. The mean bicarbonate alkalinity for the study period was 117.43 ppm with the highest single recording of 190 ppm in May 1958, from Series B. Sixty-nine (69) ppm was the lowest single recording occurring at Series B in August 1959. Carbonate alkalinity peaks occurred at both stations simultaneously, usually in slightly varying degrees and with time differences for their initiation. This occurrence showed in the form of a double peak in the spring and summer for the first two years but did not develop until May in 1960. The highest carbonate alkalinity was 24 ppm in July 1959 in Series B.

It may be noted that the total alkalinity in both impoundments which are located in what is considered low fertility watersheds, is many times less than that from the two other lakes which are in fertile watersheds.

Caddo Lake had an average pH of 6.94 for the three year period. The lowest pH recorded was 5.9 in May 1958. Throughout the study the lack of buffering which the low alkalinity afforded was characterized by the effect free carbon dioxide had on the pH. This showed

FIG. 36. A COMPARISON OF CARBONATE & BICARBONATE ALKALINITY IN LAKE CHICOT FROM JULY 1957 TO MAY 1960

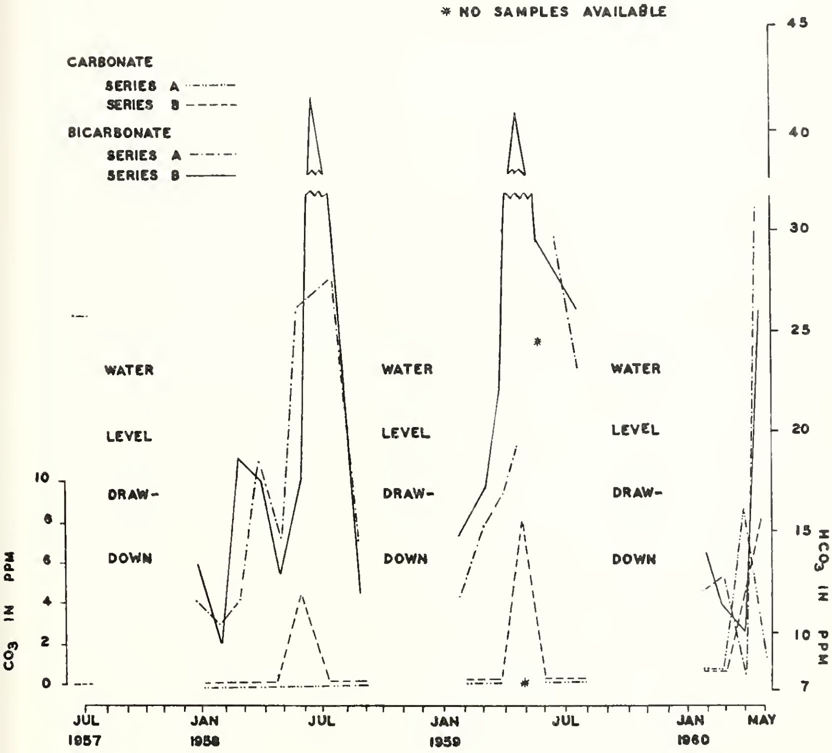
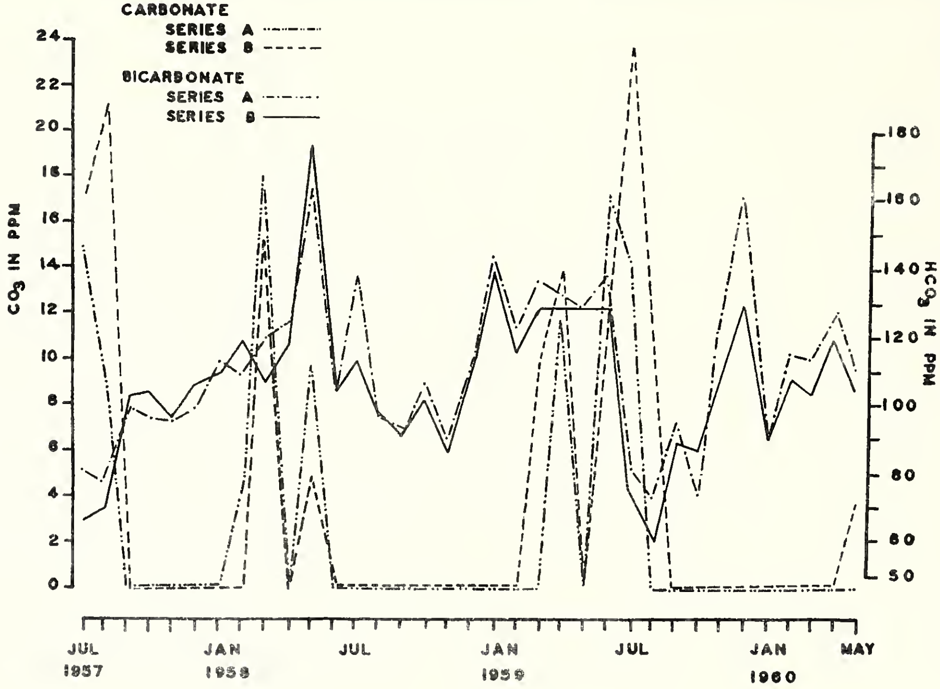


FIG. 37. A COMPARISON OF CARBONATE & BICARBONATE ALKALINITY IN LAKE PROVIDENCE FROM JULY 1957 TO MAY 1960



up as an inverse ratio. (Figures 26 and 27) Chicot Lake, which also had a low alkalinity, showed this same unstable pH with fluctuations occurring according to the free carbon dioxide increases and decreases. Chicot Lake showed a much wider range of pH than any of the other lakes, 6.1 - 9.2. The highest pH in Caddo Lake was 7.9. (Figures 30 and 31)

Cane River Lake which had the highest alkalinity content of the four lakes had the most stable pH. It did not in any of the observations go below a pH of 7.0, and highest was 8.6. (Figures 28 and 29) Periods of high carbon dioxide readings did not have the strong effect such as was noted in the lakes discussed above. Lake Providence, as with Cane River Lake, showed a relatively stable pH with only one reading of 6.9 for the acid side. The high recorded was 8.7. Here also the inverse effect of free carbon dioxide was minimized by the buffering effect of the high alkalinity. (Figures 31 and 32)

Total and available phosphate determinations were made with the available phosphate samples first being filtered. The total phosphorous samples were digested without any filtering in order to make available the bound phosphates. Unknown to the project leader, the samples for the analysis of total phosphorous were erroneously filtered for the period of September 1959 through January 1960, with the exception of November 1959. Since this procedure caused the results to include only the available phosphates plus that which had been bound in dissolved organic material and not the total phosphorous, the data for this period has been omitted.

Caddo Lake averaged the lowest available phosphate (0.046 ppm) of the four lakes, however, no seasonal trends were noted. The two series samples with few exceptions were similar in trends and quantities. The available phosphates were found to range from 0.001 to 0.198 ppm. The total phosphorous was extremely erratic with a study average of 0.205 ppm. This high total phosphorous study average may be accounted for by the large quantities of detritus which were noted when the plankton counts were conducted. Any bound phosphates present in this detritus would be released by the digesting procedure.

Chicot Lake consistently had the highest total phosphorous and this also may be accounted for by the large quantities of detritus present in the water, as was noted in the plankton samples. The available and total phosphates were erratic with recordings from 0.947 ppm to almost 0.000 ppm for total phosphorous and from 0.333 ppm to almost 0.000 ppm for available phosphates.

Cane River Lake and Lake Providence both showed a tendency for a lowering of total phosphorous in the late fall or early winter. Lake Providence averaged the highest available phosphate content (0.0707 ppm) for the study. With the exception of the above mentioned winter lowering of total phosphorous, the recordings in these lakes were also extremely variable. Also, no consistent association could be made between either the total or available phosphorous and the fall period of circulation.

In general, the phosphates were too erratic in all four lakes to present a valid picture as to total and available phosphate seasonal variations. Also, some question arises as to the thoroughness of the digesting procedure for total phosphorous. With this is the question of the source of the detritus which was present in two impoundments and not in the other two lakes. If this detritus originates in the watershed and either retains the phosphate in a bound form or is just transitory and is washed out of the lake, which may well happen in Caddo Lake which frequently has a strong current in the direction of the spillway, the question arises whether this should be considered in the lake's chemical system on the basis of fertility. However, if these results are to be used, the mean study total phosphorous would place all four lakes in the classification of very good (0.11 - 0.20 ppm) or excessive (2.15 or more ppm) according to Moyle's (1946) classification of Minnesota lakes according to the total phosphorous content.

The nitrogen analyses for the forms in which this element is found in natural waters, ammonia nitrogen, organic nitrogen, nitrate nitrogen, and nitrite nitrogen, presented the most variable data of any of the chemical analyses. Ammonia and organic nitrogen would be found extremely high in one month with a drop the following month and a subsequent high the next. The means and ranges for these two forms of nitrogen for the four lakes are given in Table 1. In general the results of the sampling stations at the two series of each lake followed the same trends.

Nitrite was present in such small quantities that some question arises as to the validity of any minor variations which were recorded. The mean results for the study period for the four lakes were: Chicot Lake, 0.010 ppm; Lake Providence, 0.017 ppm; Cane River Lake, 0.015 ppm and Caddo Lake, 0.015 ppm.

Nitrate nitrogen varied monthly but to a much lesser degree than ammonia or organic nitrogen for the three lakes which were not fluctuated. An increase in nitrate nitrogen was noted in each of these

TABLE 1

Mean and Extremes for Ammonia Nitrogen and Organic Nitrogen Values for Study Lakes from July 1957 to May 1960

	Caddo Lake						Cane River Lake						Chicot Lake						Lake Providence					
	SERIES A			SERIES B			SERIES A			SERIES B			SERIES A			SERIES B			SERIES A			SERIES B		
	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.	Low	High	Avg.
Ammonia Nitrogen:	0.075	2.10	0.4374	0.074	1.372	0.3480	0.047	1.444	0.3943	0.045	2.544	0.4126	0.046	1.032	0.3660	0.056	0.998	0.3792	0.042	0.992	0.3956	0.054	1.228	0.3353
Organic Nitrogen:	0.00	3.11	1.1191	0.020	4.00	1.2632	0.00	5.60	1.450	0.00	3.78	1.1157	0.00	4.46	1.4962	0.09	4.90	1.4418	0.05	4.13	1.5057	0.10	5.20	1.5579

Conducting Water Analysis with a Bausch and Lomb "Spectronic 20" Colorimeter

Recording Plankton Weights with a Mettler Analytical Balance three lakes for the last two years of the study during the winter and extending into early spring. This was found at both individual sampling stations. Figure 38 illustrates the averaged nitrate content for these three lakes. The mean nitrate content for the study period was 0.109 ppm for both Caddo and Chicot Lakes and 0.080 ppm for both Cane River Lake and Lake Providence.

BENTHOS

A total of 12 benthos samples were collected quarterly in two series of six samples each of the four study lakes. Sample sites were selected in Cane River Lake and Lake Providence to represent different contours and in the two impoundments to represent various sections. Table 2 illustrates the bottom types of the benthos sample sites in the study lakes. These samples were collected with a Petersen Dredge. The sample was placed in a wash tub for dilution, passed through a No. 30 mesh seive and all material which remained after mild washing was preserved in 10% formalin and returned to the New Orleans laboratory for analysis. At first these samples were hand picked to remove organisms from the detritus. However, due to the tedious nature of this work, during the last half of the study, the sugar floatation method, as described by Anderson (1959), was utilized. All weights were conducted with an analytical balance and are wet weights in which only the excess moisture has been removed by placing the organisms in a pile on blotting paper for one minute. Volume was recorded by measuring the quantity of water displaced by the sample.

The results obtained by sampling were converted to a standing crop per square foot, and are presented numerically as mean annual and project samples in Tables 3 through 6. Identification in most cases has been to family, although in some instances it is only to order or sub-order.

Tubificidae were noted to be the most numerous organisms in Lake Providence and present in the other lakes in quantities which made it one of the major numerical constituents. Tendipedidae and Sphaeriidae were the two most numerous organisms present in Caddo Lake, each with a mean numerical standing crop of 16.4 (21.81%) individuals per square foot. Also, of numerical significance in Caddo Lake was the Ephemeridae which was represented primarily by Hexagenia sp.

FIG. 38. A COMPARISON OF MEAN NITRATE VALUES AS AVERAGED FROM TWO SAMPLES FOR EACH DATE

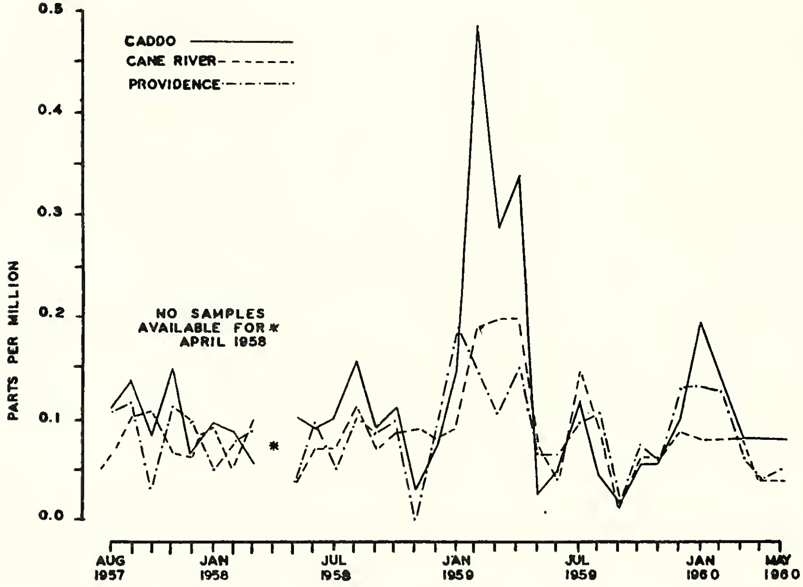


TABLE 2

Bottom Types of Benthos Sampling Sites from the Four Study Lakes

Sample No.	Caddo Lake	Cane River Lake	Chicot Lake	Lake Providence
A1.	Clay, sand, detritus	Sand and aquatics	Decaying organic matter, detritus, sand	Detritus, sand, clay
A2.	Sand and clay	Detritus, clay, sand	Detritus, clay, sand, muck, aquatics	Clay, muck, detritus
A3.	Clay and muck	Detritus, clay, sand	Detritus, muck, clay, aquatics	Muck, soft clay
A4.	Clay and muck	Detritus, clay, sand	Detritus, muck, aquatics	Muck, clay, detritus
A5.	Clay, muck, detritus	Clay and sand	Clay, muck, detritus, aquatics	Muck and soft clay
A6.	Decaying organic matter detritus, aquatics	Detritus and clay, rocks, sand	Decaying organic matter, detritus, logs, muck, clay, sand	Detritus, muck, clay
B1.	Detritus and clay	Clay and detritus	Decaying organic matter, detritus, clay, sand	Decaying organic matter, sand, detritus
B2.	Detritus and soft clay	Clay and muck	Muck, clay, detritus, aquatics, decaying organic matter	Muck, soft clay detritus
B3.	Clay and muck	Clay and muck	Muck, detritus, decaying organic matter, aquatics	Muck, clay, detritus
B4.	Hard clay, sand, detritus	Clay and muck	Detritus, aquatics, muck	Muck, clay, detritus
B5.	Clay, sand, detritus	Detritus sand, clay	Muck, detritus, aquatics	Muck, clay, sand
B6.	Decaying organic matter, clay, sand, detritus, aquatics	Detritus, hard clay, sand	Detritus, clay, muck, sand, decaying organic matter	Sand, silt, detritus

TABLE 3

Annual and Study Listings of the Number and Percentage of Organisms Occurring in a Mean Square Foot Benthos Sample as Averaged from all of the Benthos Samples Collected during each of these Periods from Lake Caddo.

	1957-58	1958-59	1959-60	Mean	Percentage
Turbellaria					
Rhabodocoelida					
Dalyellidae	Trace			Trace	
Tricladida					
Planariidae	Trace			Trace	
Nematoda	0.4		0.1	0.2	0.27
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	3.2	1.9	0.4	1.8	2.40
Pisciolidae	0.1			Trace	
Oligocheata					
Plesiopora					
Tubificidae	12.9	9.7	7.9	10.2	13.56
Prosopora					
Lumbriculidae	0.7	0.1	0.2	0.3	0.40
Branchiobdellidae	0.1			Trace	
Arachnoidea			Trace	Trace	
Hydracarina	Trace			Trace	
Crustacea					
Cladocera			0.1	Trace	
Eucopepoda	Trace	Trace	0.6	0.2	0.27
Isopoda	0.2			0.1	0.13
Asellidae			Trace	Trace	
Amphipoda					
Talitridae	6.3	5.2	2.0	4.5	5.98
Gammaridae	4.0	1.9	0.4	2.1	2.79
Mysidacea	0.1			Trace	
Decapoda					
Cambarinae	Trace			Trace	
Insecta					
Ephemeroptera					
Ephemeridae	0.8	16.0	9.9	8.9	11.83
Baetidae			4.1	1.4	1.86
Odonata					
Anisoptera		0.1		Trace	
Libellulidae	0.1	0.2	0.2	0.2	0.27
Cordulesteridae			0.1	Trace	
Zygoptera					
Coenagrionidae	0.1	0.1	0.1	0.1	0.13
Agrionidae					
Megaloptera					
Sialidae		Trace		Trace	
Tricoptera	0.8	0.1	0.4	0.4	0.53
Diptera					
Tabanidae	0.6			0.2	0.27
Tendipedidae	1.2	21.0	27.0	16.4	21.81
Ceratopogonidae	0.4	0.4	0.5	0.4	0.53
Culicidae					
Chaoborinae		2.6	16.0	6.2	8.24
Coleoptera			Trace	Trace	
Hydrophilidae			0.3	0.1	0.13
Haliplidae	0.4	Trace		0.1	0.13
Elmidae		Trace	0.1	Trace	
Dytisicidae			0.2	0.1	0.13
Pelecypoda					
Heterodonta					
Sphaeriidae	27.8	14.9	6.5	16.4	21.81
Eulamellibranchia					
Unionidae	0.3	0.6	0.3	0.4	0.53
Gastropoda					
Prosobranchia					
Viviparidae	1.8	2.5	3.5	2.6	3.46
Pulmonata					
Physidae		3.4		1.1	1.46
Lymnaeidae	2.0	0.1		0.7	0.93
Planorbidae	0.2			0.1	0.13
TOTAL	64.5	80.8	80.9	75.2	99.98

TABLE 4

Annual and Study Listings of the Number and Percentage of Organisms Occurring in a Mean Square Foot Benthos Sample as Averaged from all of the Benthos Samples Collected during each of these Periods from Cane River Lake.

	1957-58	1958-59	1959-60	Mean	Percentage
Turbellaria					
Rhabdocoelida					
Dalyellidae	0.6			0.2	0.10
Tricladida					
Planariidae	1.7			0.6	0.30
Nematoda	0.2		0.4	0.2	0.10
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	0.2	0.2	0.3	0.2	0.10
Oligocheata					
Plesiopora					
Tubificidae	69.9	53.2	55.8	59.6	29.90
Prosopora					
Lumbriculidae	0.1	0.6	0.3	0.3	0.15
Crustacea					
Cladocera	Trace		0.3	0.1	0.05
Eucopepoda	0.7		20.4	7.0	3.51
Ostracoda					
Podocopa			0.5	0.2	0.10
Amphipoda					
Talitridae	0.1	0.4	0.3	0.3	0.15
Mysidacea			Trace	Trace	Trace
Insecte					
Ephemeroptera					
Ephemeridae	0.7	0.6		0.4	0.20
Baetidae			0.4	0.1	0.05
Odonata					
Zygoptera					
Coenagrionidae	0.3	0.4	0.1	0.3	0.15
Tricoptera	Trace			Trace	
Diptera					
Tendipedidae	16.6	107.5	99.9	74.7	37.48
Ceratopogonidae	0.3	0.2	1.4	0.6	0.30
Culicidae					
Chaoborinae	24.3	22.6	113.3	53.4	26.79
Coleoptera					
Elmidae		0.1	0.5	0.3	0.15
Gyrinidae			Trace	Trace	Trace
Haliplidae	Trace			Trace	Trace
Dytisicidae	0.4			0.1	0.05
Arachnoidea			Trace	Trace	
Pelecypoda					
Heterodonta					
Sphaeriidae	0.1	1.0		0.4	0.20
Eulamellibranchie					
Unionidae			0.1	Trace	Trace
Gastropoda					
Prosobranchia					
Vivipariidae	0.1	0.1	0.1	0.1	0.05
Pulmonata					
Physidae		0.2		0.1	0.05
Planorbidae	0.4			0.1	0.05
TOTAL	116.7	187.1	294.1	199.3	99.82

TABLE 5

Annual and Study Listings of the Number and Percentage of Organisms Occurring in a Mean Square Foot Benthos Sample as Averaged from all of the Benthos Samples Collected during each of these Periods from Chicot Lake.

	1957-58	1958-59	1959-60	Mean	Percentage
Nematoda		0.1		Trace	
Phylactolaemata					
Pulmatellina					
Lophopodidae		0.1		Trace	
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	Trace	0.1	0.3	0.1	0.18
Oligocheata					
Plesipora					
Tubificidae	26.4	10.9	6.6	14.6	25.97
Prosopora					
Lumbriculidae	0.5	0.4	0.4	0.4	0.71
Crustacea					
Eucopepoda	Trace			Trace	
Amphipoda					
Gammaridae		0.2		0.1	0.18
Talitridae	0.3	1.7	2.5	1.5	2.67
Isopoda					
Asellidae		0.1		Trace	
Decapoda					
Palaemonidae			0.1	Trace	
Insecta					
Ephemeroptera					
Ephemeridae		0.1		Trace	
Odonata					
Anisoptera					
Libellulidae	0.3		0.1	0.1	0.18
Zygoptera					
Coenagrionidae	0.1			Trace	
Tricoptera			0.4	0.1	0.18
Diptera					
Tendipedidae	1.0	6.6	4.3	4.0	7.12
Ceratopogonidae	0.5	0.2	0.1	0.3	0.53
Culicidae					
Chaoborinae	4.1	43.0	52.0	33.0	58.72
Coleoptera		0.1		Trace	
Hydrophilidae			0.2	0.1	0.18
Haliplidae	0.9		0.1	0.3	0.53
Pelecypoda					
Heterodonta					
Sphaeriidae	2.1	2.3	0.4	1.6	2.85
Gastropoda					
Prosobranchia					
Viviparidae	0.1			Trace	
TOTAL	36.3	65.9	67.5	56.2	100.00

TABLE 6

Annual and Study Listings of the Number and Percentage of Organisms Occurring in a Mean Square Foot Benthos Sample as Averaged from all of the Benthos Samples Collected during each of these Periods from Lake Providence.

	1957-58	1958-59	1959-60	Mean	Percentage
Turbellaria	0.9			0.3	0.15
Tricladida					
Planariidae			1.7	0.6	0.30
Nematoda	0.4			0.1	0.05
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	3.2	0.7	1.0	1.6	0.81
Oligocheata					
Plesiopora					
Tubificidae	104.2	45.5	45.3	65.0	32.94
Aeolosomatidae	2.1			0.7	0.36
Naididae	Trace			Trace	
Prosopora					
Lumbriculidae	0.9	0.8	3.2	1.6	0.81
Crustacea					
Cladocera			0.2	0.1	0.05
Eucopepoda	0.1		6.2	2.1	1.06
Ostracoda					
Podocopa			1.1	0.4	0.20
Amphipoda					
Talitridae	27.6	3.2	19.6	16.8	8.51
Gammaridae	2.5	0.1		0.9	0.46
Insecta					
Ephemeroptera					
Ephemeridae	0.1	0.5	2.8	1.1	0.56
Baetidae		0.4	2.7	1.0	0.51
Odonata					
Anisoptera					
Libellulidae	0.1	0.1	0.1	0.1	0.05
Zygoptera					
Coenagrionidae		0.2		0.1	0.05
Tricoptera			0.4	0.1	0.05
Diptera					
Tendipedidae	76.4	33.2	69.5	59.7	30.26
Ceratopogonidae	0.5	0.1	0.6	0.4	0.20
Culicidae					
Chaoborinae	9.8	27.0	74.7	37.2	18.85
Coleoptera		Trace	Trace	Trace	
Gyrinidae			Trace		
Haliplidae	0.3			0.1	0.05
Elmidae			0.4	0.1	0.05
Dytisicidae			0.1	Trace	
Hymenoptera			0.1	Trace	
Pelecypoda					
Heterodonta					
Sphaeriidae	10.9	7.3	1.0	6.4	3.24
Eulamellibranchia					
Unionidae		0.1	1.5	0.5	0.25
Gastropoda					
Prosobranchia					
Viviparidae	0.1	Trace	0.4	0.2	0.10
Pulmonata					
Lymnaeidae	0.3			0.1	0.05
TOTAL	240.4	119.2	232.6	197.3	99.97

Caddo Lake presented the greatest number of types of organisms with a total of 41, Lake Providence and Cane River Lake were next with 31 and 28 different types respectively. Chicot Lake had the least variety with a total of 22 types. Caddo Lake had the highest gravimetric results with a mean standing crop of 1.49 grams per square foot and the highest volume of 1.44 ml. A majority of this weight and volumetric displacement may be attributed by mollusk which were more numerous than in other lakes. Primarily, they were the larger Unionidae which were of considerable size and, therefore, very few individuals would increase the averages.

Lake Providence had the second highest gravimetric and volumetric benthos with a mean study standing crop of 0.61 grams per square foot and 0.66 ml. volume. Chicot Lake's standing crop was 0.19 grams per square foot and 0.31 ml. volume and the standing crop in Cane River Lake was 0.35 grams per square foot and 0.42 volume. (Figures 39 and 40)

Caddo Lake shows a variation from the concept of Welch (1952) that the winter standing crop is the greatest. However, this may be attributed to the occurrence of large Unionidae, which as previously stated, requires only one or two individuals to effect the over all mean standing crop. Table 7 illustrates the seasonal mean standing crop with all the Mollusca included compared with the seasonal mean standing crop minus the Unionidae for the last year of the study.

Cane River Lake showed a peak mean standing crop occurring in January; however, when the two sampling series are considered separately the mean standing crop per series is found to differ considerably. (Figure 41) The greatest variation occurring in the spring and summer of 1959. At that time Series B deviates from the trend of a maximum standing crop in January. This difference further illustrates the possibility of factors being different at the two series sampling sites which are 24 miles apart and which vary in depth.

Lake Providence presented the most consistent seasonal trend in the mean standing crop. The peak always appearing in January and the minimum in July and August. This similarity in seasonal standing crop fluctuations is found in the mean of both sampling series. The volumertric displacement analyses also presented figures closely following this same seasonal variation.

The benthos sampling was too scattered to present a true picture of the seasonal trends in Chicot Lake. However, what information is available indicates a close similarity between the mean standing benthos crop of the two sampling series.

FIG. 39. A COMPARISON OF THE MEAN GRAVIMETRIC BENTHOS STANDING CROP PRODUCTION AS AVERAGED FROM 12-1 FT.^{2} SAMPLES COLLECTED FOR EACH DATE

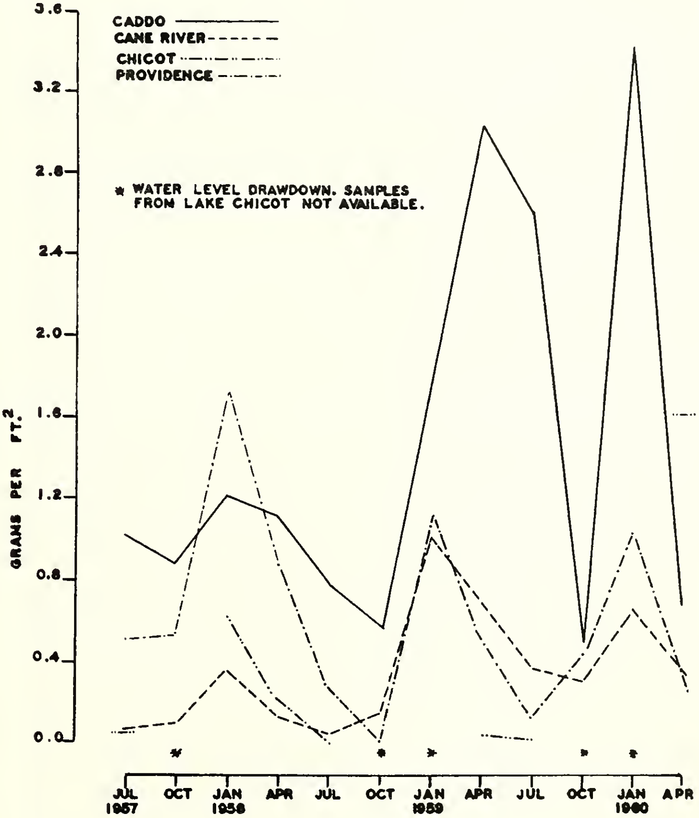


FIG. 40. A COMPARISON OF THE MEAN VOLUMETRIC BENTHOS STANDING CROP PRODUCTION AS AVERAGED FROM 12– 1 FT. SAMPLES COLLECTED FOR EACH DATE

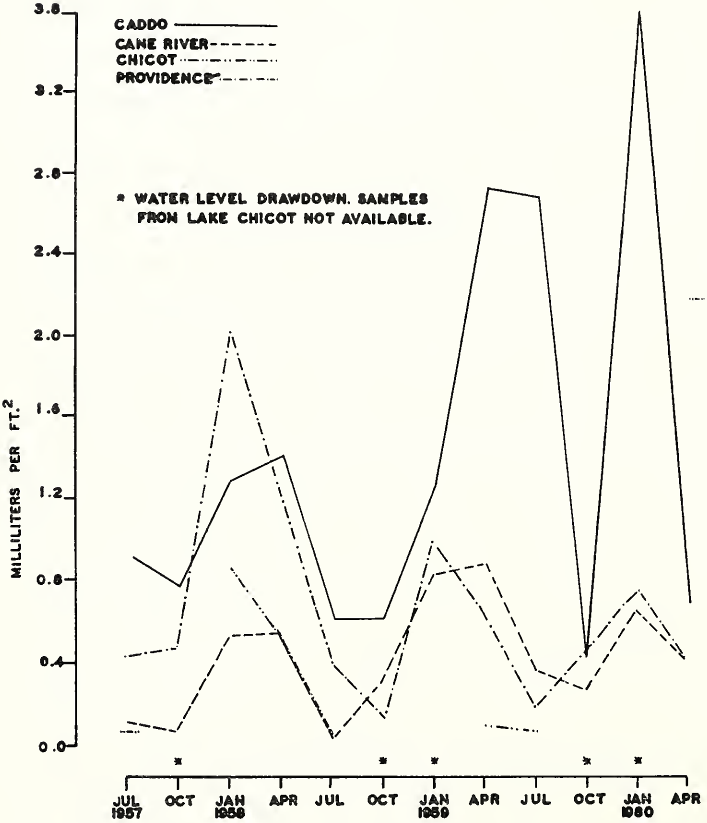
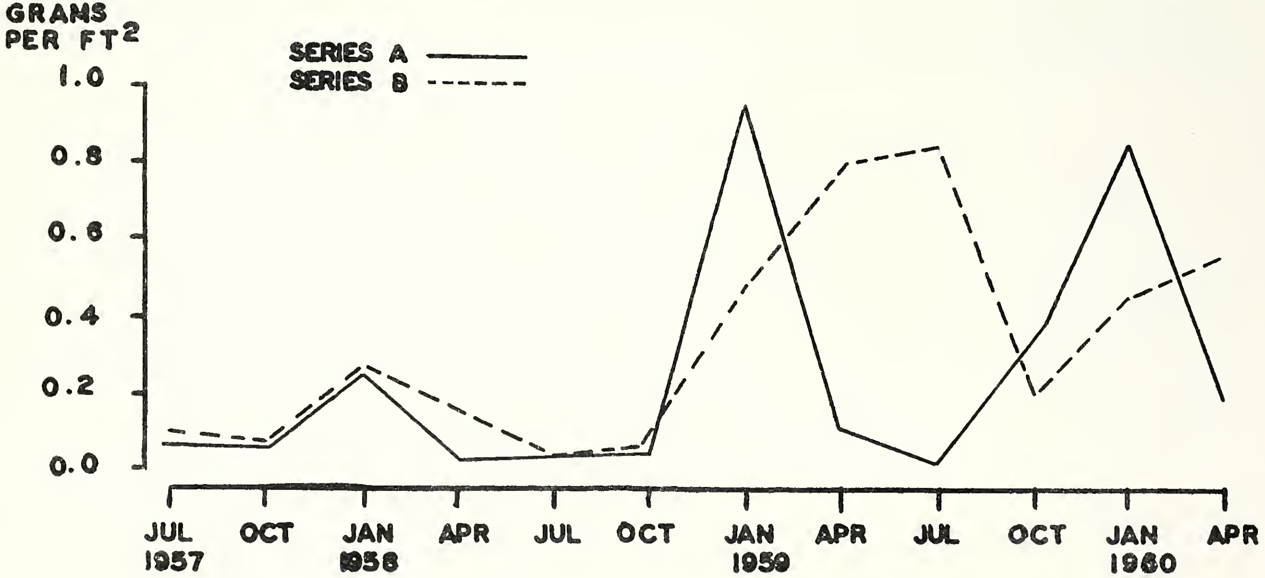


TABLE 7

Comparison of the Mean Gravimetric Standing Crop Production per Square Foot of Bottom Fauna as Averaged from Twelve Square Foot Samples for each Date Including Unionidae and Excluding Unionidae from Caddo Lake.

	Grams per Square Foot Without Unionidae Recorded	Grams per Square Foot With Unionidae Recorded
July 1959	0.3636	2.6128
October 1959	0.2055	0.5196
January 1960	0.3683	3.4447
April 1960	0.5534	0.6923
Mean	0.3727	1.8173

FIG. 41. A COMPARISON BETWEEN SERIES A & B OF CANE RIVER LAKE AS AVERAGED FROM 6-1 FT.^{2} BENTHOS SAMPLES COLLECTED FOR EACH DATE.



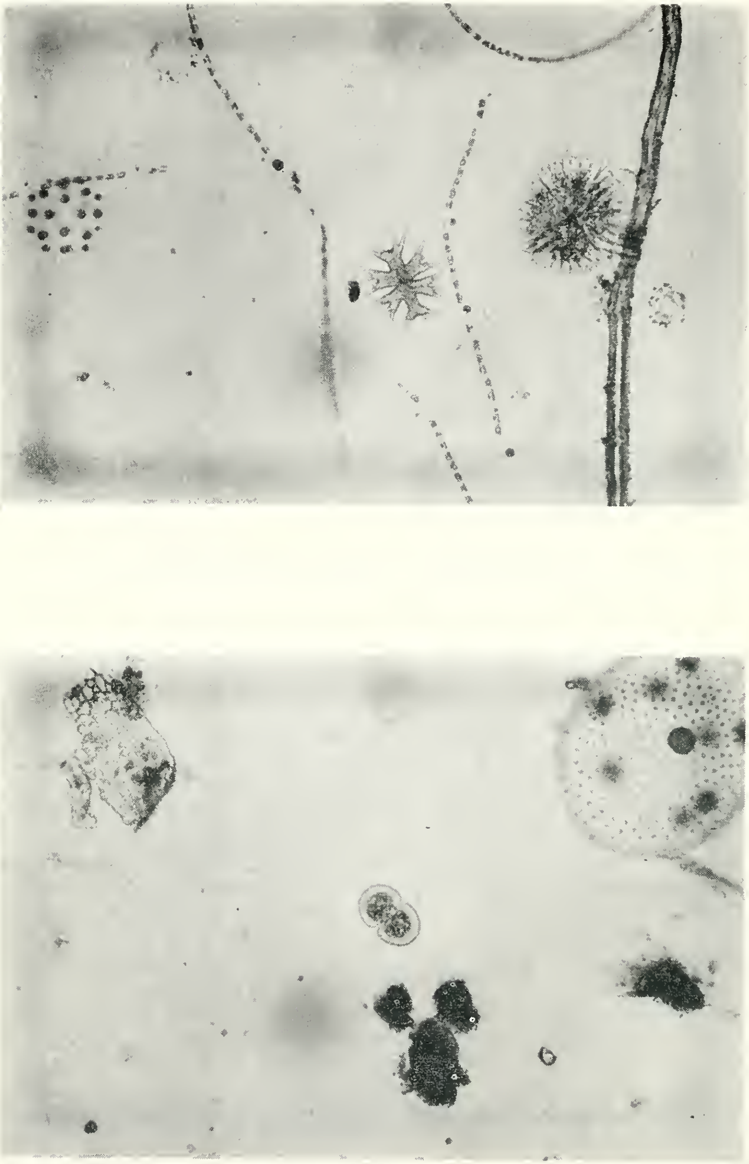
Over half the total number of organisms of Chicot Lake was represented by Chaoborinae which was 33 (58.72%) individuals per square foot. The only other organisms present in any quantity was the previously mentioned Tubificidae. Chaoborinae also constituted a major numerical part of the production in Cane River Lake, 53.4 individuals or 26.79%. Tendipedidae averaged 74.7 (37.48%) in Cane River Lake and they were the most abundant of any organisms in all four lakes.

PLANKTON

Net and nanno samples were collected monthly with a portable power pump at a depth of three feet at one permanent sampling site in each of the two series in each of the four lakes. One 20 liter net plankton sample was collected and preserved in 10% formalin for identification and count analyses. A second 20 liter net plankton sample was collected from the same site and preserved in 70% alcohol for gravimetric analysis. A one liter sample of water filtered through the plankton net was collected for nanno plankton, concentrated with a Foerst centrifuge and preserved in 70% alcohol.

Laboratory net plankton counts and identification were conducted using a Sedgwick-Rafter counting cell and a Whipple ocular micrometer. These samples were concentrated to one milliliter of concentrate equal to one liter of the original sample. Gravimetric analyses for both net and nanno plankton were conducted by dehydrating the samples at 55°C for 24 hours, recording the dehydrated weight and then incinerating in a furnace at 600°C for 30 minutes, cooling in a desiccator and re-weighing. The difference recorded is either net or nanno plankton organic material.

Gravimetric net and nanno plankton results were erratic throughout the study period and only the net plankton results from Cane River Lake indicated any seasonal trends. There a peak production was noted during the winter period each year and a minimum during the summer. Plankton counts of the larger plankters which included Cladocera, Copepods, and nauplii (Eucopepoda) followed similar trends as the gravimetric analysis. (See Figures 42 through 45) Cane River Lake also had the highest mean study gravimetric net, (0.3800 gm/M^3) and nanno (5.50 gm/M^3) plankton results for the three year period.



Plankton Samples from Chicot Lake

FIG. 42. MEAN NUMBER OF LARGE ZOOPLANKTORS AS AVERAGED FROM TWO SAMPLES MONTHLY FROM LAKE CADDO

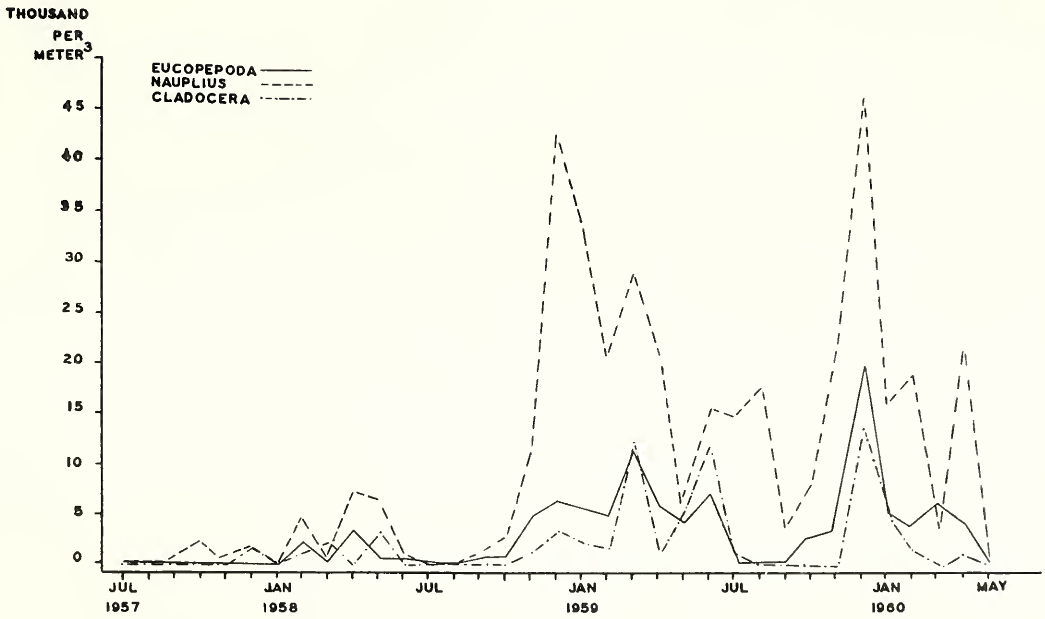


FIG. 43. MEAN NUMBER OF LARGE ZOOPLANKTORS AS AVERAGED FROM TWO SAMPLES MONTHLY FROM CANE RIVER LAKE

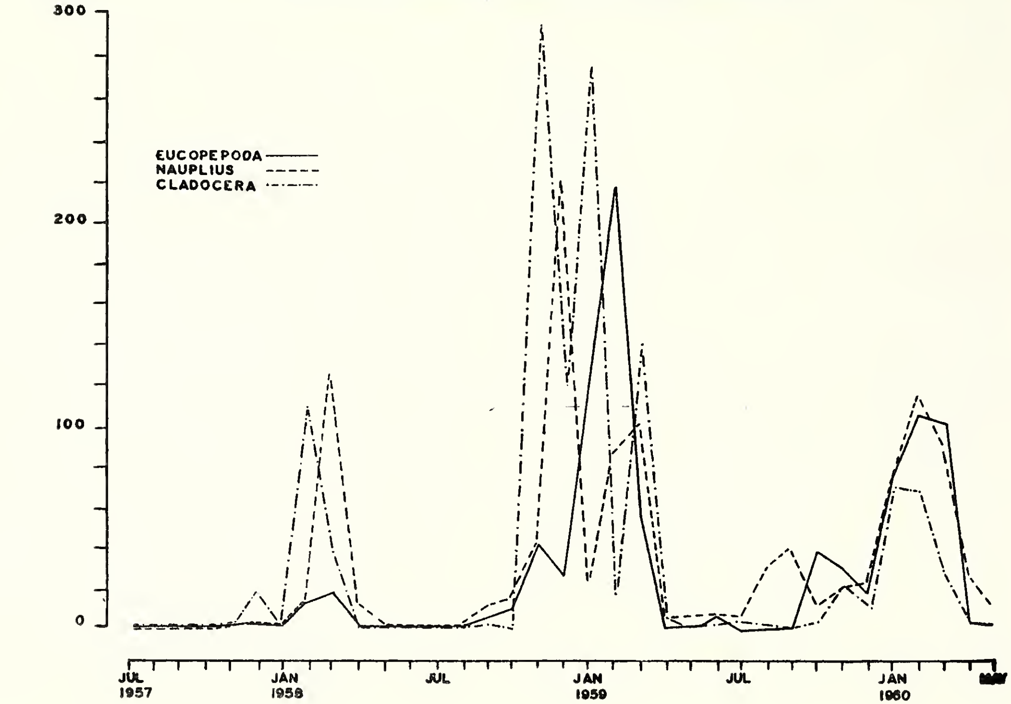


FIG. 44. MEAN NUMBER OF LARGE ZOOPLANKTORS AS AVERAGED FROM TWO SAMPLES MONTHLY FROM LAKE CHICOT

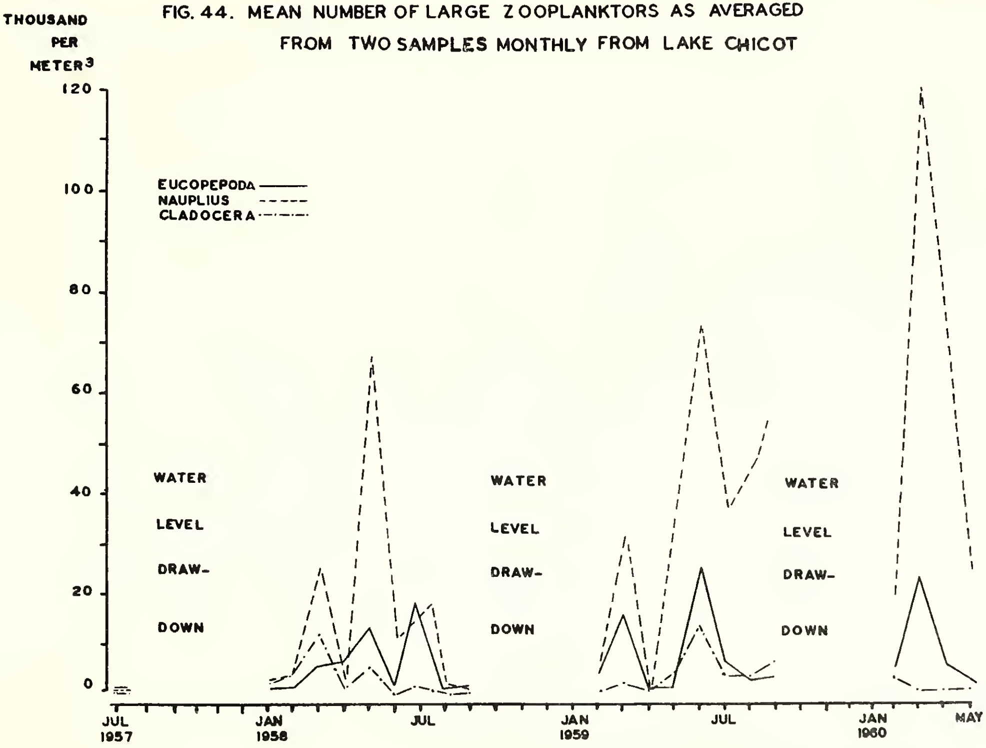
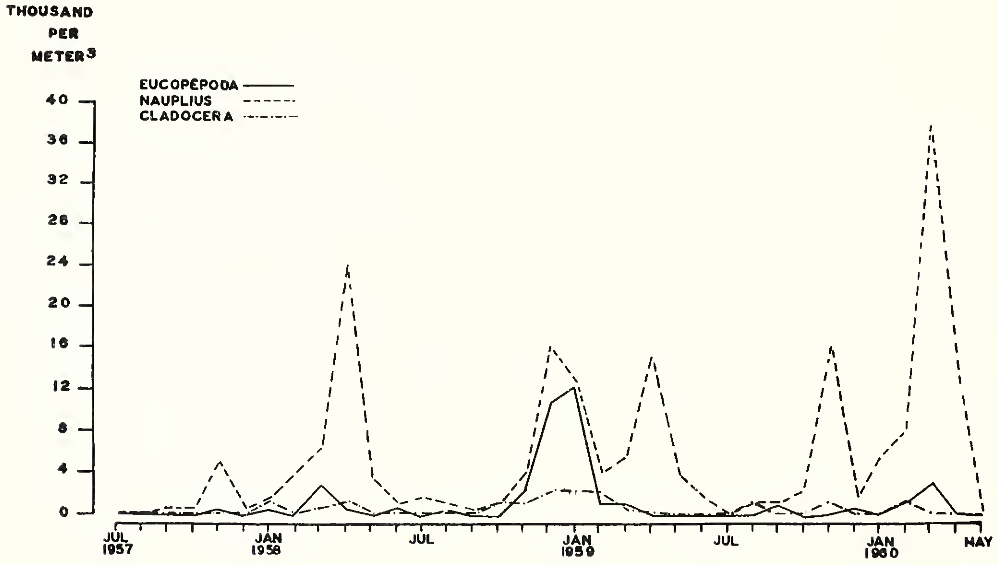


FIG. 45. MEAN NUMBER OF LARGE ZOOPLANKTORS AS AVERAGED FROM TWO SAMPLES MONTHLY FROM LAKE PROVIDENCE



Lake Providence plankton counts showed similar winter peaks for these larger plankters although the Cladocera and Copepods were not as numerous, particularly Cladocera. Nauplii did appear in greater quantities than the two preceding organisms, but in a lesser degree than in Cane River Lake. The mean gravimetric net plankton results were lowest from Lake Providence. (0.1885 gm/M^3) while the nanno production (4.81 gm/M^3) was second to Cane River Lake.

Counts of the larger plankters from Caddo Lake also showed seasonal trends with a winter maxima and a summer minima. As with Lake Providence, these were lesser quantities than those noted in Cane River Lake. These periods of increase for these organisms, Cladocera, Copepods, and nauplii, prevailed over longer periods of time than in either of the two preceding lakes.

Quantities of the larger plankters in Chicot Lake showed the effect of the water level draw-down. In this lake the peak production of the organisms, numerically, took place in the spring and early summer.

The mean gravimetric total plankton production for the four lakes during the three year study period showed similarity between the ox-bow and the old river lake and between the two impoundments. These results for the ox-bow, Lake Providence, (4.9985 gm/M^3), and the old river, Cane River Lake (5.8800 gm/M^3), were one quarter and one half again as great, respectively, as those for the two impoundments, Caddo Lake (4.0776 gm/M^3) and Chicot Lake (3.8688 gm/M^3).

It is fully realized that the erratic gravimetric results both for net and nanno plankton may be due to the sampling procedures. Considering the short term life cycles of some plankters, and the diurnal vertical migration of plankton, it would be desirable to sample more frequently than once a month. However, this was impossible as was the ability to be at each station at the same time of day. In order to stabilize the sampling procedures as much as possible, the standard depth of three feet was selected, and the stations were located in the center portions of the study lakes to do away with the effect of wind action in forming windrows of organisms.

The results of the plankton counts are given in Figure 46 through 49 in the form of Lohmann graphs as described by Birge and Juday (1922). Organisms counts presented here are based on a value of one individual equaling a radius length of 0.25 millimeters and the original diagrams have been reduced to one half size.

FIG. 46. ILLUSTRATION OF THE QUANTITATIVE SEASONAL CHANGES IN THE NET PLANKTON OF LAKE CADDO RECORDED IN NUMBER PER CUBIC METER

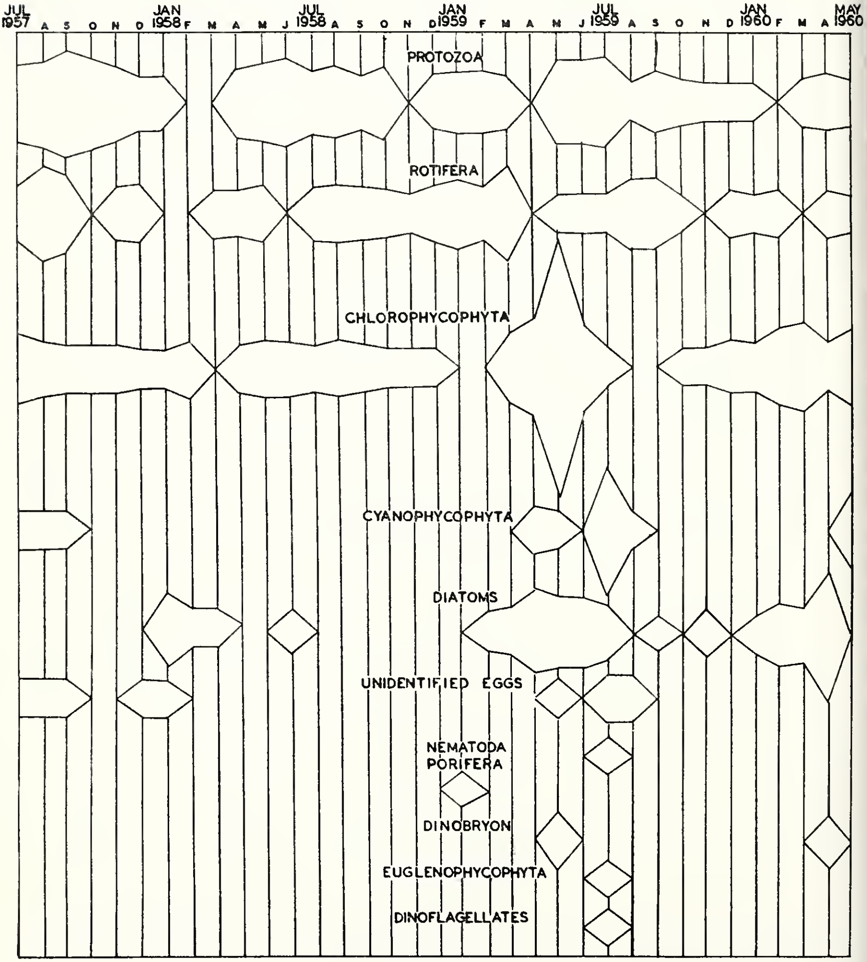


FIG. 47. ILLUSTRATION OF THE QUANTITATIVE SEASONAL CHANGES IN THE NET PLANKTON OF CANE RIVER LAKE RECORDED IN NUMBER PER CUBIC METER

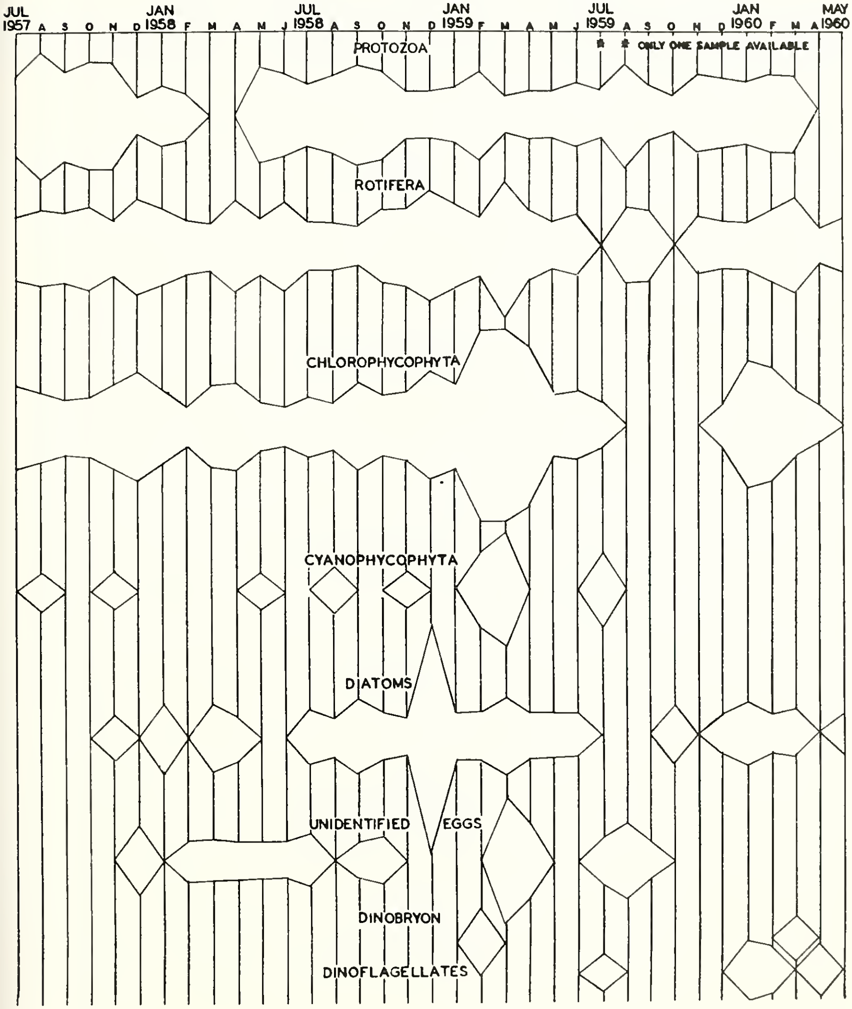


FIG. 48. ILLUSTRATION OF THE QUANTITATIVE SEASONA
CHANGES IN THE NET PLANKTON OF LAKE CHICOT
RECORDED IN NUMBER PER CUBIC METER

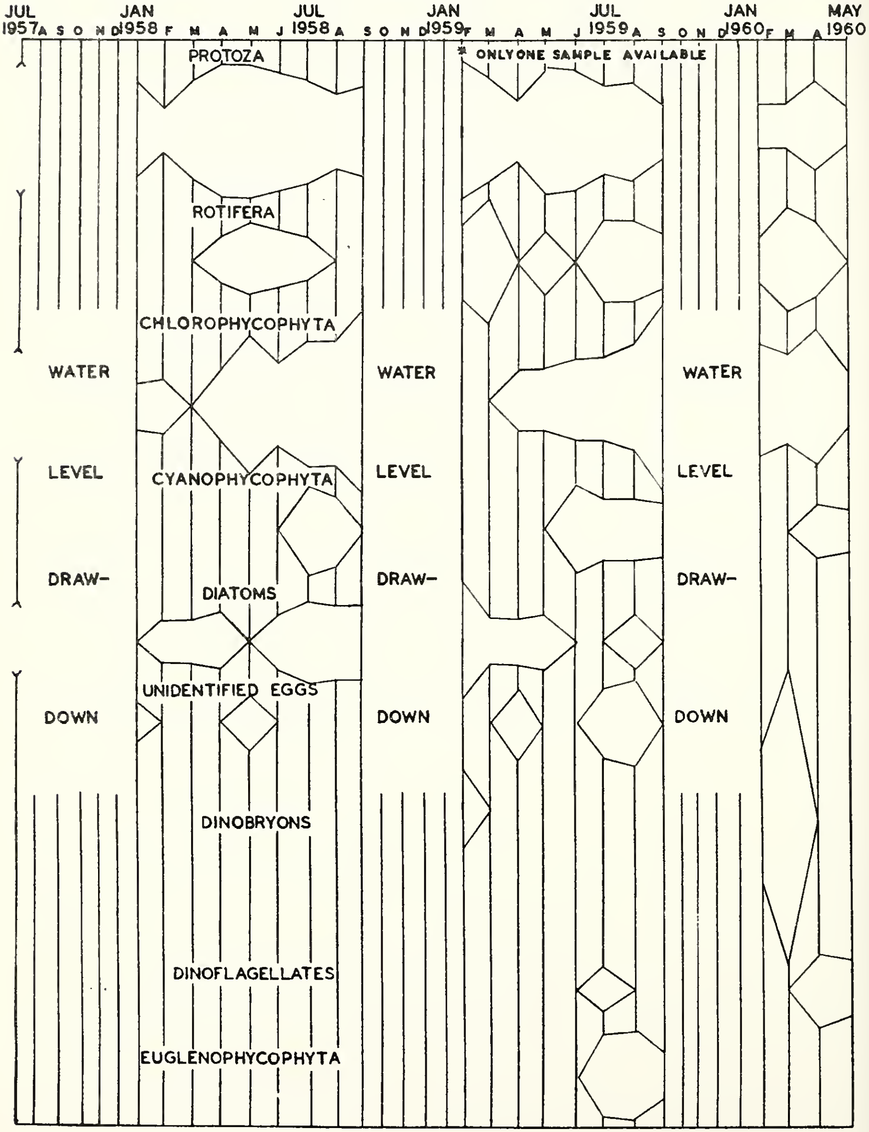
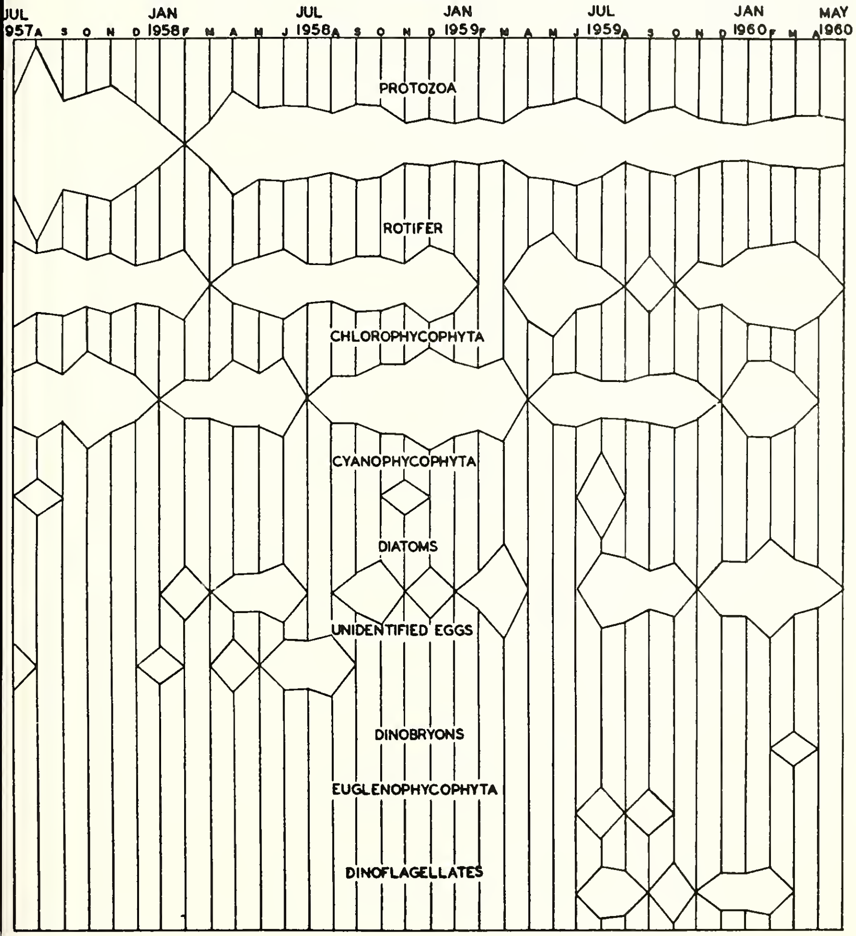


FIG. 49. ILLUSTRATION OF THE QUANTITATIVE SEASONAL CHANGES IN THE NET PLANKTON OF LAKE PROVIDENCE RECORDED IN NUMBER PER CUBIC METER



ABUNDANCE OF YOUNG FISH OF THE YEAR

Six 600 square foot samples were collected in each of the four study lakes in early summer of each year. Samples taken in sections which would not permit a full 600 square foot sample were converted to that area. All sampling was conducted with a 30 foot nylon bobbinet minnow seine. Sampling was performed under the supervision of the project leader by non-project personnel employed by the Louisiana Wild Life and Fisheries Commission.

Figures 50 through 53 illustrate the results of these samples. In Caddo Lake the results from the three years varied considerably for all species taken. All species which had been collected in the first two years showed a decline for 1960. The one exception was largemouth bass, Micropterus salmoides which showed a steady increase each year. Two new species were present in 1960 samples; yellow bass, Roccus mississipiensis and white crappie, Pomoxis annularis, although in small numbers. Cane River Lake also showed a decrease in 1960 with the exception of largemouth bass. The largemouth bass reproduction results for this lake were higher each year than for any of the three other study lakes. A desirable feature of the annual trend in Cane River Lake is the disappearance of the orange-spotted sunfish, Lepomis humilis from the samples after 1958 and gradual deminishing of the numbers of longear sunfish, Lepomis megalotis. Stunted individuals of these two species had presented a problem in this lake.

Chicot Lake reproduction samples showed a successful spawn for all species in 1960 compared to 1959. Of particular interest is the increase in the young of the year for largemouth bass population. This is exceeded only by the bluegill, Lepomis macrochirus production. The 1959 samples were the lowest for each species with the exception of the bluegill young of the year.

The results from Lake Providence are questionable because of the characteristics of the lake. With very little exception, the shore is lined with cypress trees which extend into the water and out to a depth which prohibits the use of a minnow seine. Therefore, the results given here are not representative of the lake as a whole. This is further shown in the limited number of species and fish taken.

FISH FOOD STUDIES

While it is realized the accepted and preferred method of presenting fish stomachs analysis data is in terms of volume, the results of this report are presented in terms of numerical abundance. This was made necessary due to the need of having a common ground for

FIG. 50. YOUNG OF THE YEAR FROM LAKE CADDO AS AVERAGED FROM SIX- 600 FT.^{2} MINNOW SEINE SAMPLES

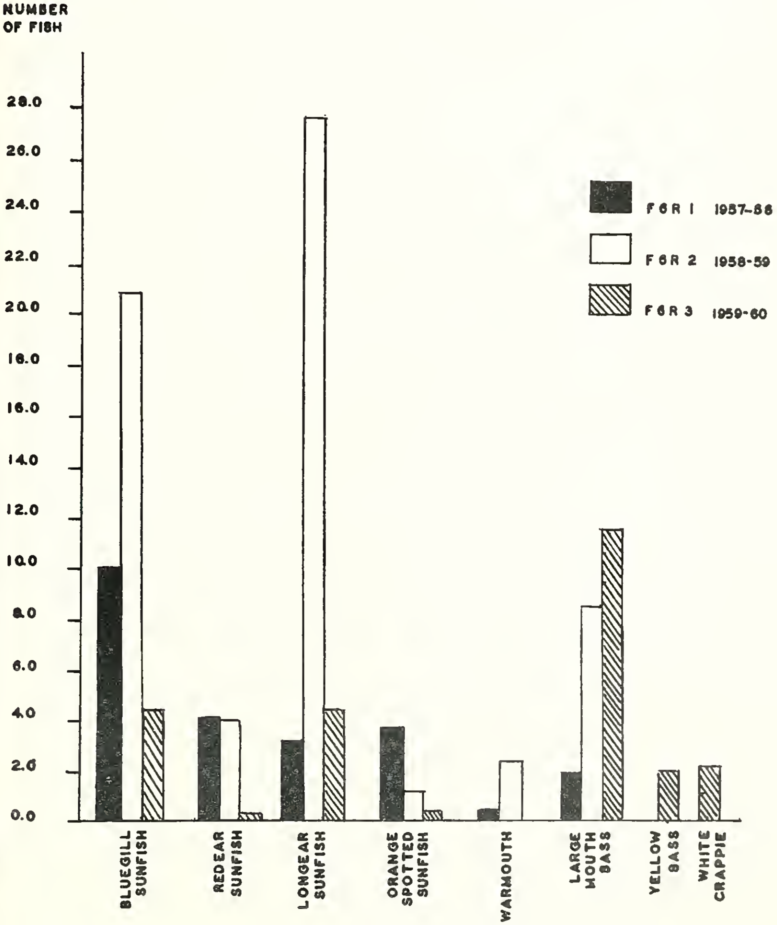


FIG. 51. YOUNG OF THE YEAR FROM CANE RIVER LAKE AS AVERAGED FROM SIX - 600 FT.^{2} MINNOW SEINE SAMPLES

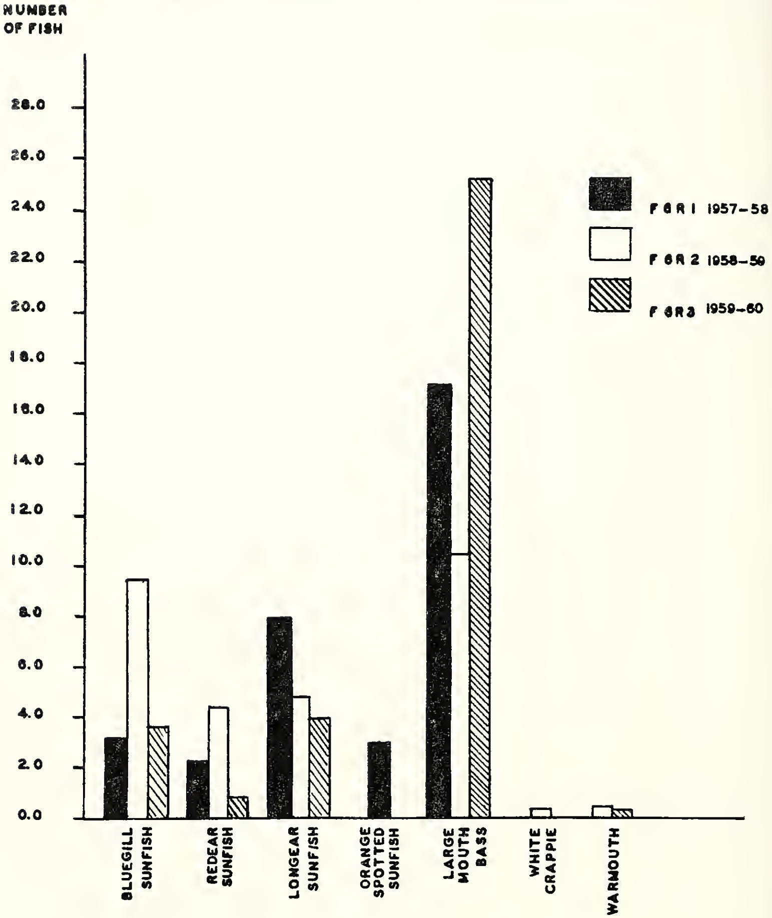


FIG. 52. YOUNG OF THE YEAR FROM LAKE CHICOT AS AVERAGED FROM SIX-600 FT.^{2} MINNOW SEINE SAMPLES

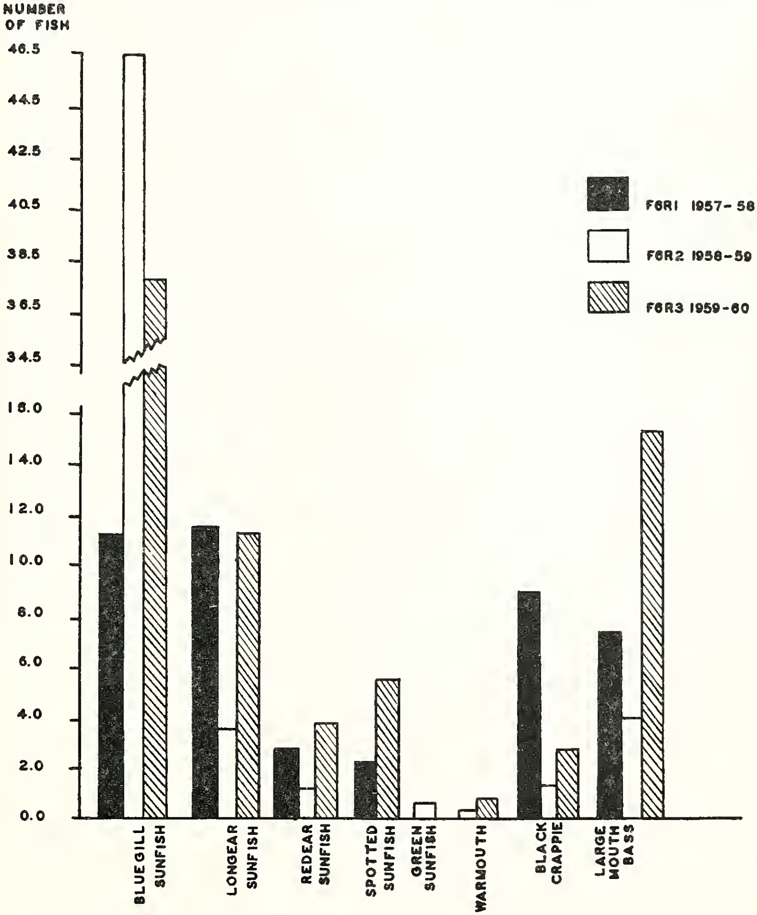
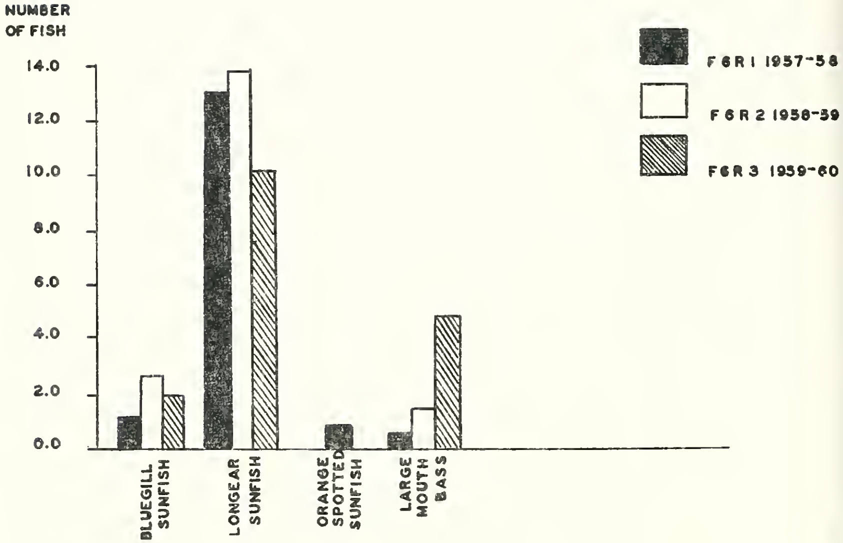


FIG.53. YOUNG OF THE YEAR FROM LAKE PROVIDENCE AS AVERAGED FROM SIX-600 FT MINNOW SEINE SAMPLES



comparison of abundance of organisms in the benthos results with this data. Project personnel and time were not available to obtain the volumetric displacement values on all individual groups in the benthos and stomach samples. However, it should be fully realized that numerical results do not present the true value of individual organisms as food. For example, a larger organism, such as a fish, may constitute a very small percentage numerically, but actually make up the bulk of a stomach content volumetrically and, therefore, be far more important from a nutritional point.

Tables 8 through 14 present the results of these analyses. The two most extensively sampled species of fish were the bluegill and the redear, Lepomis microlophus. Yellow bass stomachs were taken only in Caddo Lake in any quantity and only four specimens were collected in Lake Providence. Warmouth, Chaenobryttus gulosus stomachs were available from all lakes except Cane River Lake; black crappie, Pomoxis nigromaculatus were collected in Caddo and Chicot Lakes and white crappie in Caddo and Cane River Lakes. Longear sunfish stomach samples were taken only in Caddo and Providence Lakes. Table 14 presents the data for the analyses of 19 freshwater drum, Aplodinotus grunniens stomach samples for Caddo Lake. These were the only non-game species collected for stomach analyses. The purpose being to attempt to determine their utilization of the benthos production, since this is the most predominate species of fish in Caddo Lake.

Numerically, Tendipedidae were the most important group occurring in bluegill stomach samples. On a percentage basis this group was exceeded only in Caddo Lake as having the highest occurrence. In Cane River Lake, Tendipedidae (60.48%) and Ostracoda (31.59%) together comprised 92.07% of the total number of organisms taken by this fish species. In Lake Providence the Tendipedidae (85.50%) and the Ostracoda (8.56%) make up 94.06% of the total numer of organisms taken.

The redear sunfish also showed a high utilization of Tendipedidae in all four lakes. However, the group was exceeded in occurrence in redear stomach samples in Caddo Lake as with the bluegill, by the Ephemeridae. Of interest is the preference of this species of fish, the redear, for Mollusca. While the bluegill's stomach content consisted of only 1.42% Mollusca, the redear's stomach content contained 35.84% Mollusca, consisting of 13.92% Sphaeriidae; 0.58% Unionidae, and 21.34% Viviparidae. In Cane River Lake the redear showed different food preferences than the bluegill by taking no Ostracods, but instead taking Eucopepoda (23.46%). In Lake Providence Tendipedidae (82.76%) and Mollusca (8.62%) were the groups taken in any quantity by redear.

TABLE 8

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Redear (Lepomis microlophus) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959

	CADDO LAKE 137 Specimens			CANE RIVER LAKE 65 Specimens			CHICOT LAKE 33 Specimens			LAKE PROVIDENCE 52 Specimens		
ORGANISMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Nematoda	2	2	0.23							1	1	0.57
Hirudinea												
Rhynchobdellida												
Glossiphoniidae	3	5	0.58	1	4	2.47	2	3	0.33			
Crustacea												
Cladocera							2	53	5.79			
Ostracoda												
Podocopa				1	1	0.62	1	3	0.33	1	1	0.57
Eucopepoda	7	12	1.39	6	38	23.46	6	85	9.29	2	2	1.15
Amphipoda	1	1	0.11									
Talitridae	12	16	1.86	1	2	1.23	5	35	3.82	3	4	2.30
Decapoda												
Palaemonidae	1	1	0.11							1	1	0.57
Arachnoidea												
Hydracarina	2	2	0.23									
Insecta				2	2	1.23	1	2	0.22			
Ephemeroptera												
Ephemeridae	47	270	31.32									
Baetidae							1	1	0.11			
Odonata							1	1	0.11			
Anisoptera										1	1	0.57
Libellulidae	1	1	0.11				2	2	0.22			
Zygoptera							1	1	0.11			
Cordulegasteridae							2	4	0.44			
Coenagrionidae				1	1	0.62						
Tricoptera				1	1	0.62				1	1	0.57
Diptera												
Tendipedidae	58	234	27.14	20	106	65.43	12	679	74.21	29	144	82.76
Ceratopogonidae	2	2	0.23	2	2	1.23						
Culicidae												
Chaoborinae	5	6	0.70	3	3	1.85	4	46	5.03	1	3	1.72
Coleoptera										1	1	0.57
Pelecypoda												
Heterodonta												
Sphaeriidae	45	120	13.92							9	10	5.75
Eulamellibranchia												
Unionidae	2	5	0.58									
Gastropoda												
Prosobranchia												
Viviparidae	42	184	21.34							3	5	2.87
Vertebrata												
Pisces												
Clupeidae				1	1	0.62						
Centrarchidae	1	1	0.11									
Digested Fish				1	1	0.62						
TOTAL	231	862	99.96	40	162	100.00	40	915	100.01	52	174	99.97

TABLE 9

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Bluegill (Lepomis macrochirus) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959.

	CADDO LAKE 60 Specimens			CANE RIVER LAKE 106 Specimens			CHICOT LAKE 108 Specimens			LAKE PROVIDENCE 98 Specimens		
ORGANSIMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Nematoda	13	106	18.86				4	3	0.66			
Hirudinea												
Rhynchobdellida												
Glossiphoniidae	1	1	0.18				4	5	0.11			
Oligocheata				1	1	0.08						
Crustacea												
Ostracoda	11	29	5.16	40	399	31.59	22	279	6.06	17	365	8.56
Podacopa												
Cladocera	8	12	2.14	6	6	0.48	38	1039	22.57	2	10	0.23
Eucopepepoda	5	12	2.14	2	2	0.16	33	233	5.06	1	3	0.07
Isopoda												
Sphaeromidae							4	54	1.17			
Asellidae							5	9	0.20			
Amphipoda	1	1	0.18									
Talitridae	8	34	6.05	2	26	2.06	57	971	21.09	26	162	3.80
Decapoda												
Cambarinae				1	1	0.08						
Palaemonidae	2	2	0.36				13	22	0.48	1	3	0.07
Arachnoidea				1	1	0.08	1	4	0.09			
Hydracarina	3	3	0.53	2	2	0.16	21	38	0.82	2	1	0.02
Insecta	1	1	0.18	2	9	0.71				2	7	0.16
Plecoptera							1	1	0.02	1	1	0.02
Ephemeroptera												
Ephemeridae	12	217	38.61				1	1	0.02	5	16	0.38
Baetidae	1	1	0.18	2	4	0.32	11	41	0.89	5	9	0.21
Odonata							3	6	0.13	2	2	0.05
Anisoptera							1	1	0.02			
Aeschinidae							1	1	0.02			
Libellulidae	1	1	0.18				10	60	1.30	2	2	0.05
Zygoptera							9	13	0.28			
Coenagrionidae							3	3	0.06			
Gomphidae										1	1	0.02
Cordulegasteridae							7	36	0.78			
Hemiptera				1	1	0.08						
Tricoptera	6	19	3.38	2	2	0.16	5	29	0.63	2	2	0.05
Diptera												
Tendipedidae	31	114	20.28	71	764	60.48	56	1638	35.58	71	3646	85.50
Ceratopogonidae				2	2	0.16	6	9	0.20	3	7	0.16
Culicidae												
Chaoborinae				3	36	2.85	16	47	1.02	1	4	0.09
Coleoptera				1	1	0.08	3	3	0.06	1	1	0.02
Gyrinidae				1	1	0.08	1	1	0.02			
Elmidae				1	2	0.16						
Chrysomelidae										1	1	0.02
Dytiscidae							2	2	0.04			
Formacoidea							1	1	0.02			
Pelecypoda												
Heterodonta												
Sphaeriidae	4	7	1.24	1	1	0.08	4	25	0.54	1	1	0.02
Gastropoda												
Prosobranchia												
Vivipariidae	1	1	0.18				1	1	0.02			
Pulmonata												
Physidae							1	1	0.02			
Vertebrata												
Pisces												
Cyprinidae							1	1	0.02	8	14	0.33
Notropis										2	2	0.05
Centrarchidae							1	1	0.02	4	6	0.14
Lepomis							5	18	0.39	1	1	0.02
Atherinidae				1	1	0.08	2	8	0.17	1	1	0.02
Digested Fish	1	1	0.18	1	1	0.08	3	3	0.06	1	1	0.02
TOTAL	110	562	100.01	141	1263	100.01	357	4603	100.03	164	4263	100.03

TABLE 10

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Largemouth Bass (Micropterus salmoides) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959

	CADDO LAKE 18 Specimens			CANE RIVER LAKE 58 Specimens			CHICOT LAKE 5 Specimens			LAKE PROVIDENCE 46 Specimens		
ORGANISMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Nematoda	1	1	2.86				3	3	3.75	6	9	21.43
Hirudinea												
Rhynchobdellida												
Glossiphoniidae	1	4	11.43				2	2	2.50			
Crustacea												
Cladocera							1	4	5.00			
Ostracoda												
Podocopa	1	2	5.71				2	2	2.50			
Eucopepoda							1	9	11.25			
Decapoda												
Cambarinae	1	1	2.86							1	1	2.38
Insecta										1	1	2.38
Ephemeroptera												
Baetidae	1	1	2.86									
Diptera												
Tendipedidae	2	2	5.71	1	1	1.45	4	11	13.75	1	1	2.38
Culicidae												
Chaoborinae										1	1	2.38
Pisces												
Clupeidae	4	10	28.57	12	16	23.19						
Esocidae							1	1	1.25			
Cyprinidae	2	2	5.71	1	2	2.90	1	2	2.50	3	3	7.14
Ictaluridae				1	1	1.45						
Centrarchidae				5	6	8.70				8	12	28.57
Lepomis				3	3	4.38	7	39	48.75	5	8	19.05
Micropterus				6	6	8.70						
Percidae												
Athernidae	1	1	2.86	4	5	7.25	2	5	6.25			
Digested Fish	8	11	31.43	26	29	42.03	2	2	2.50	6	6	14.28
TOTAL	22	35	100.00	59	69	100.05	26	80	100.00	32	42	99.99

TABLE 11

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Black Crappie (*Pomoxis nigromaculatus*) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959

	CADDO LAKE 5 Specimens			CHICOT LAKE 40 Specimens		
ORGANISMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Nematoda				2	2	0.08
Crustacea						
Cladocera				13	93	3.72
Ostracoda						
Podocopa				7	20	0.80
Eucopepoda				16	425	17.02
Amphipoda						
Talitridae	1	4	7.27	23	130	5.21
Decapoda						
Palaemonidae				4	16	0.64
Arachnoidea						
Hydracarina				4	8	0.32
Insecta				11	151	6.05
Ephemeroptera						
Baetidae	1	7	12.73	2	3	0.12
Ephemeridae	2	34	61.82	1	2	0.08
Odonata				1	2	0.08
Libellulidae				1	2	0.08
Coleoptera						
Circulionidae				1	1	0.04
Diptera						
Tendipedidae	1	1	1.82	28	609	24.39
Culicidae						
Chaoborinae				22	1004	40.21
Ceratopogonidae				1	1	0.04
Vertebrata						
Pisces						
Clupeidae						
Cyprinidae	4	6	10.91			
Centrarchidae						
Lepomis				10	19	0.76
Athernidae				3	7	0.28
Digested Fish	2	3	5.45	4	4	0.16
TOTAL	11	55	100.00	154	2497	100.08

TABLE 12

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Warmouth (Chaenobryttus gulosus) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959

	CADDO LAKE 9 Specimens			CHICOT LAKE 78 Specimens			LAKE PROVIDENCE 26 Specimens		
ORGANISMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Nematoda				5	47	3.94			
Hirudinea									
Rhynchobdellida									
Glossiphoniidae				4	18	1.51			
Oligocheata									
Plesiopora									
Tubificidae							1	3	5.77
Crustacea									
Eucopepoda				4	13	1.09			
Cladocera				5	8	0.67			
Ostracoda									
Podocopa				3	4	0.34			
Amphipoda									
Talitridae	2	5	22.73	6	13	1.09	2	3	5.77
Gammaridae									
Decapoda									
Cambarinae				3	2	0.25	2	2	3.85
Palaemonidae				30	62	5.20			
Insecta				3	3	0.33			
Ephemeroptera									
Ephemeridae	2	3	13.64	1	1	0.08			
Baetidae				3	3	0.25	1	1	1.92
Odonata									
Zygoptera				1	2	1.67			
Cordulegasteridae				3	10	0.84			
Coenagrionidae							1	1	1.92
Diptera									
Tendipedidae	3	3	13.64	9	958	80.30	5	11	21.15
Culicidae									
Chaoborinae				6	28	2.35			
Tricoptera							6	18	34.61
Coleoptera									
Elmidae				1	1	0.08			
Gastropoda									
Prosobranchia									
Vivipariidae				1	1	0.08			
Vertebrata									
Pisces									
Clupeidae	2	4	18.18						
Cyprinidae							1	2	3.85
Notropis	1	1	4.54				1	1	1.92
Centrarchidae				3	3	0.25	4	5	9.62
Lepomis				7	11	0.92	3	5	9.62
Atherinidae	1	5	22.73	3	4	0.34			
Digested Fish	1	1	4.54	3	4	0.34			
TOTAL	12	22	100.00	104	1193	101.92	27	52	100.00

TABLE 13

A Listing of the Frequency, Number, and Percentage of Food Items Occurring in the Stomach Contents of Yellow Bass (*Roccus mississipiensis*) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959.

	CADDO LAKE 71 Specimens			LAKE PROVIDENCE 4 Specimens		
ORGANISMS	Frequency	Total No. per Item	Percent of Total	Frequency	Total No. per Item	Percent of Total
Hirudinae						
Rhynchobdellidae						
Glossiphoniidae	1	2	0.55			
Crustacea						
Decapoda						
Palaemonidae	2	5	1.38			
Insecta				1	7	21.88
Odonota						
Libellulidae	1	1	0.28			
Ephemeroptera						
Ephemeridae	12	205	56.63			
Diptera						
Tendipedidae	7	10	2.76	1	6	18.75
Culicidae						
Chaoborinae	1	3	0.83			
Vertebrata						
Pisces						
Clupeidae	24	76	20.99	1	2	6.25
Cyprinidae	1	1	0.28	2	9	28.12
Centrarchidae						
Lepomis				1	7	21.88
Athernidae	1	1	0.28			
Digested Fish	23	58	16.02	1	1	3.12
TOTAL	78	362	100.00	7	32	100.00

TABLE 14

A Listing of the Frequency, Number, and Percentage of Food Items Occurr in the Stomach Contents of Drum (Aplodinotus grunniens) taken by Rotenone Poisoning from the Study Lakes during the Summers of 1958 and 1959

	CADDO LAKE 19 Specimens			
ORGANISMS	Frequency	Total No. per Item	Percent of Total	
Insecta				
Ephemeroptera				
Ephemeridae	7	37	59.68	
Diptera				
Tendipedidae	5	15	24.19	
Ceratopogonidae	2	2	3.22	
Pelecypoda				
Heterodonta				
Sphaeriidae	1	1	1.61	
Vertebrata				
Pisces				
Cyprinidae	1	1	1.61	
Atherinidae	2	5	8.06	
Digested Fish	1	1	1.61	
TOTAL	19	62	99.98	

In evaluating the results of stomach contents taken from predaceous species collected with rotenone, it must be considered that these species will feed on smaller fish which are affected first by the chemical before succumbing to the effects themselves. Therefore, rotenone sampling is not the preferred stomach sampling method but as the stomachs collected for this project were taken by non-project personnel, this method had to be accepted.

As would be expected vertebrates made up the bulk of the contents of the largemouth bass stomachs examined. Largemouth bass stomachs from Chicot Lake contained the highest percentage of invertebrates with Tendipedidae present in largest quantities (13.75%). Of the vertebrates taken, Clupeidae constituted the main group in largemouth bass stomachs from Caddo Lake (28.75%) and Cane River Lake (23.19%). In Chicot Lake and Lake Providence, the Centrachidae were most abundantly taken 48.75% and 47.62% respectively.

In general the group of organisms which was most constantly found in the stomach content as a major constituent was the Tendipedidae, except in the basses and white crappie. White crappie was the only fish that did not have any Tendipedidae in their stomach contents in any lake. The only other group which equaled the Tendipedidae in numerical occurrences, with the exception of the above species of fish, was the Ephemeridae in Caddo Lake.

FISH POPULATION SAMPLES

Rotenone population samples were collected by enclosing a one-acre area with a one-inch mesh webbing. Five percent emulsified rotenone was then applied within the enclosed area with a portable power sprayer both on and below the surface. All fish which surfaced were collected and recorded. The webbing was allowed to remain enclosing the sample area until the following day. At that time, fish which were killed and not collected on the preceding day were bloated from internal decomposition gases and were floating within the net enclosed sample area. These fish were collected and recorded and the results added with the results of the first day to present a sample total.

The results of rotenone samples to evaluate the fish population standing crop production are given in Tables 15 through 18. Samples from Chicot Lake presented the lowest mean production for the study, 29.32 pounds per acre. The high was 35.2 pounds per acre in 1960 and the low was 19.1 pounds per acre in 1958. The low for1958 could be attributed to the fish kill which occurred during the late summer of 1957 (Geagan 1960). Predator-prey relationship, utilizing the method described by Lambou (1959), had a ratio of 1:2.9 for the study. The water fluctuation program employed in this lake has kept the total standing crop low, but at the same time has minimized the standing crop of undesirable non-game species. In 1960, three years after the fish kill of 1957, the gizzard shad, Dorosoma cepedianum constituted only 0.6% of the total production. Due to its ability to become over abundant or even pre-dominant, this species is considered one of the major fish management problems in Louisiana. Game species have contributed over half the total standing crop production each year with a high in 1960 of 89.8%. Bluegill have developed into the important forage species with warmouth being next. Largemouth bass and black crappie are the major predators and by 1960 were relatively equal in abundance.

Caddo Lake had the second lowest mean standing crop production as determined by rotenone samples. This was 59.61 pounds per acre with a low of 44.5 pounds in 1958 and a high of 77.6 pounds in 1959. The mean predator-prey relationship for the three years samples was 1:0.2. Game fish production never exceeded one-third of the total with the mean being 22.36% of the total. The most predominate game forage species was the redear sunfish for all three years. The two most important game predaceous species were largemouth bass and yellow bass. The most abundant single species was the freshwater drum, a little utilized commercial fish in Louisiana. This species constituted a mean production of 36.57% of the total standing crop for the study period. The channel catfish, Ictalurus punctatus, and longnose gar, Lepisosteus osseus were the two most abundant non-game predaceous species with a mean study standing crop of 8.44% and 5.82% respectively of the mean study total standing crop production.

Cane River Lake had the highest mean study standing crop production of 262.36 pounds per acre. However, 75.12% of this was gizzard shad and threadfin shad, Dorosoma pentenese. This high production of these two forage species was responsible for the high predator-prey relationship which averaged 1:10.3 for the three year period. The largemouth bass is the most important predaceous fish, both game and non-game. Game species have made up between 7.5% of the total standing crop in 1958 and 14.7% in 1960. However, the percentage of these which are of available size was 64.4% in 1958 and 42.4% in 1960. The commercial fish population was primarily composed of carp, Cyprinus carpio each year. This, as with freshwater drum, has a poor demand on the commercial fish market in Louisiana.

TABLE 15

Mean One-Acre Annual Rotenone Fish Population Samples as Averaged from Six One-Acre Samples Collected Annually from Lake Caddo

SPECIES	1958		1959		1960		Study Average	
	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%
Forage Fish								
Gizzard shad	7.6	17.1	11.0	14.2	10.4	18.3	9.67	16.22
Threadfin shad	0.1	0.2	-	-	0.1	0.2	0.07	0.12
Bluegill	0.9	2.0	1.3	1.7	0.5	0.9	0.90	1.51
Redear sunfish	4.3	9.7	5.8	7.5	7.8	13.8	5.97	10.02
Longear sunfish	0.6	1.3	0.5	0.6	0.4	0.7	0.50	0.84
Orange spotted sunfish	-	-	-	-	0.2	0.4	0.07	0.12
Spotted sunfish	-	-	0.1	0.1	-	-	0.03	0.05
Freshwater drum	11.0	24.7	33.2	42.8	21.2	37.4	21.80	36.57
Warmouth	0.3	0.7	0.3	0.4	0.4	0.7	0.33	0.55
Smallmouth buffalo	0.7	1.6	9.4	12.1	2.1	3.7	4.07	6.83
Bigmouth buffalo	0.6	1.3	-	-	0.4	0.7	0.33	0.55
Carpsucker	0.3	0.7	-	-	-	-	0.10	0.17
Spotted sucker	-	-	-	-	0.2	0.4	0.07	0.12
TOTAL	26.4	59.3	61.6	79.4	43.7	77.1	43.91	73.66
Predaceous Fish								
Largemouth bass	2.4	5.4	0.8	1.0	1.8	3.2	1.67	2.80
Spotted bass	-	-	0.2	0.3	0.2	0.4	0.13	0.22
Yellow bass	4.2	9.4	3.4	4.4	1.7	3.0	3.10	5.20
White crappie	0.8	1.8	-	-	0.6	1.0	0.47	0.79
Black crappie	0.4	0.9	-	-	0.1	0.2	0.17	0.28
Channel catfish	4.4	9.9	6.5	8.4	4.2	7.4	5.03	8.44
Yellow catfish	1.2	2.7	1.7	2.2	0.8	1.4	1.23	2.06
Spotted gar	0.4	0.9	0.2	0.3	0.7	1.2	0.43	0.72
Longnose gar	4.3	9.7	3.2	4.1	2.9	5.1	3.47	5.82
TOTAL	18.1	40.7	16.0	20.6	13.0	22.9	15.70	26.34
Grand Total	44.5	100.0	77.6	100.0	56.7	100.0	59.61	99.99
Game Fish	13.9	31.2	12.4	16.0	13.7	24.2	13.33	22.36
Available Game Fish	10.5	23.6	8.9	11.5	8.0	14.1	9.13	15.31
Commercial Fish	18.2	40.9	50.8	65.5	28.7	50.6	32.57	54.64
Available Commercial Fish	11.8	26.5	38.0	49.0	19.9	35.1	23.23	38.97
Fish Under 5 Inches	5.2	11.7	2.7	3.5	2.3	4.0	3.40	5.70
Carnivorous Fish Over 5 Inches	17.6	39.6	15.6	20.1	12.5	22.0	15.23	25.55

TABLE 16

Mean One-Acre Annual Rotenone Fish Population Sample as Averaged from Three One-Acre Samples Collected Annually from Cane River Lake

SPECIES	1958		1959		1960		Study Average	
	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%
Forage Fish								
Gizzard shad	37.8	18.6	97.0	28.8	161.4	65.5	98.73	37.63
Threadfin shad	111.2	54.8	174.6	51.8	9.3	3.8	98.37	37.49
Bluegill	2.6	1.3	7.3	2.2	9.9	4.0	6.60	2.52
Redear sunfish	0.4	0.2	2.5	0.7	4.9	2.0	2.60	0.99
Longear sunfish	1.4	0.7	1.0	0.3	10.9	4.4	4.43	1.69
Orange spotted sunfish	0.1	0.1	0.1	Trace	0.6	0.2	0.57	0.22
Spotted sunfish	-	-	-	-	0.1	Trace	0.03	0.01
Green sunfish	-	-	0.1	Trace	-	-	0.03	0.01
Carp	35.2	17.3	40.1	11.9	35.0	14.2	36.77	14.02
Freshwater drum	1.2	0.6	-	-	2.8	1.1	1.33	0.51
Warmouth	0.1	0.1	0.4	0.1	0.6	0.2	0.37	0.14
Buffalo	0.3	0.1	-	-	-	-	0.10	0.04
Yellow bullhead	0.1	0.1	-	-	-	-	0.03	0.01
Black bullhead	0.5	0.2	-	-	-	-	0.17	0.06
TOTAL	190.9	94.1	323.1	95.8	235.5	95.6	250.13	95.34
Predaceous Fish								
Largemouth bass	10.6	5.2	13.4	4.0	7.6	3.1	10.53	4.01
Yellow bass	-	-	-	-	0.1	Trace	0.03	0.01
White crappie	-	-	-	-	1.0	0.4	0.33	0.12
Black crappie	-	-	-	-	0.5	0.2	0.17	0.06
Channel catfish	1.4	0.7	0.8	0.2	0.2	0.1	0.80	0.30
Blue catfish	-	-	-	-	1.0	0.4	0.33	0.12
Spotted gar	-	-	-	-	0.5	0.2	0.17	0.06
TOTAL	12.0	5.9	14.2	4.2	10.9	4.4	12.36	4.71
Grand Total	202.9	100.0	337.3	100.0	246.4	100.0	262.36	100.00
Game Fish	15.2	7.5	24.8	7.4	36.2	14.7	25.40	9.68
Available Game Fish	9.8	4.8	12.5	3.7	15.3	6.2	12.53	4.78
Commercial Fish	38.6	19.0	0.8	0.2	39.0	15.8	26.13	9.96
Available Commercial Fish	11.1	5.5	0.8	0.2	5.0	2.0	5.63	2.14
Fish Under 5 Inches	123.6	60.9	190.5	56.5	61.2	24.8	124.02	47.27
Carnivorous Fish Over 5 Inches	11.9	5.9	13.9	4.1	10.1	4.1	11.97	4.56

TABLE 17

Mean One-Acre Annual Rotenone Fish Population Sample as Averaged from Three One-Acre Samples Collected Annually from Chicot Lake

SPECIES	1958		1959		1960		Study Average	
	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%
Forage Fish								
Gizzard shad	1.1	5.8	6.9	20.4	2.0	0.6	3.33	11.36
Bluegill	4.5	23.6	11.3	33.3	15.9	45.2	10.57	36.05
Redear sunfish	0.1	0.5	1.7	5.0	1.9	5.4	1.23	4.20
Longear sunfish	-	-	-	-	0.2	0.6	0.07	0.24
Spotted sunfish	-	-	0.1	0.3	-	-	0.03	0.10
Orange spotted sunfish	-	-	-	-	0.7	2.0	0.23	0.78
Pigmy sunfish	0.7	3.7	-	-	-	-	0.23	0.78
Warmouth	4.3	22.5	2.6	7.7	6.3	17.9	4.40	15.01
Black bullhead	0.2	1.0	-	-	-	-	0.07	0.24
Yellow bullhead	1.0	5.2	0.5	1.5	-	-	0.50	1.70
Lake chubsucker	-	-	2.5	7.4	1.5	4.3	1.33	4.54
American eel	0.3	1.6	-	-	-	-	0.10	0.34
TOTAL	12.2	63.9	25.8	76.1	28.5	81.0	22.09	75.34
Predaceous Fish								
Largemouth bass	1.4	7.3	4.0	11.8	3.1	8.8	2.83	9.65
Black crappie	0.5	2.6	4.1	12.1	3.5	9.9	2.70	9.21
Spotted gar	4.7	24.6	-	-	-	-	1.57	5.35
Mud pickerel	0.3	1.6	-	-	0.1	0.3	0.13	0.44
TOTAL	6.9	36.1	8.1	23.9	6.7	19.0	7.23	24.66
Grand Total	19.1	100.0	33.9	100.0	35.2	100.0	29.32	100.00
Game Fish	10.8	56.5	23.8	70.2	31.6	89.8	22.07	75.27
Available Game Fish	3.3	17.3	6.3	18.6	7.7	21.9	5.77	19.68
Commercial Fish	-	-	-	-	-	-	-	-
Available Commercial Fish	-	-	-	-	-	-	-	-
Fish Under 5 Inches	8.6	45.0	15.6	46.2	21.8	61.9	15.33	53.28
Carnivorous Fish Over 5 Inches	6.1	31.9	5.6	16.5	4.0	11.4	5.23	17.84

TABLE 18

Mean One-Acre Annual Rotenone Fish Population Sample as Averaged from Three One-Acre Samples Collected Annually from Lake Providence

SPECIES	1958		1959		1960		Study Average	
	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%	Lbs./ Acre	%
Forage Fish								
Gizzard shad	85.5	28.3	43.3	22.4	94.2	43.7	74.33	32.09
Threadfin shad	86.5	28.7	5.3	2.7	8.1	3.8	33.33	14.39
Bluegill	16.4	5.4	58.6	30.3	25.8	12.0	33.60	14.50
Redear sunfish	4.1	1.4	2.8	1.5	1.2	0.6	2.70	1.16
Longear sunfish	14.0	4.6	25.0	12.9	15.2	7.0	18.07	7.80
Green sunfish	0.5	0.2	1.0	0.5	0.1	-	0.53	0.23
Spotted sunfish	0.3	0.1	0.7	0.4	-	-	0.33	0.14
Warmouth	1.1	0.4	5.2	2.7	1.2	0.6	2.50	1.08
Carp	5.9	2.0	3.2	1.7	5.6	2.6	4.90	0.21
Freshwater drum	21.7	7.2	11.7	6.1	7.4	3.4	13.60	5.87
Black buffalo	-	-	-	-	7.1	3.3	2.36	1.02
Bigmouth buffalo	1.2	0.4	-	-	1.2	0.6	1.10	0.47
Smallmouth buffalo	-	-	0.5	0.3	3.8	1.8	1.43	0.62
Yellow bullhead	0.9	0.3	0.5	0.3	-	-	0.47	0.20
TOTAL	238.1	78.9	157.8	81.7	170.9	79.3	189.25	81.70
Predaceous Fish								
Largemouth bass	14.9	4.9	22.0	11.4	4.6	2.1	13.83	5.97
Yellow bass	0.9	0.3	2.7	1.4	2.4	1.1	1.57	0.68
Black crappie	0.1	-	-	-	-	-	0.03	0.01
Channel catfish	15.2	5.0	8.5	4.4	31.0	14.4	18.23	7.87
Blue catfish	2.2	0.7	-	-	-	-	0.73	0.32
Bowfin	1.9	0.6	2.1	1.1	1.3	0.6	1.77	0.76
Longnose gar	24.8	8.2	-	-	-	-	3.27	1.41
Spotted gar	3.8	1.3	-	-	5.1	2.4	2.97	1.28
TOTAL	63.8	21.1	35.3	18.3	44.7	20.7	42.40	18.30
Grand Total	301.9	100.0	193.1	100.0	215.6	100.0	231.65	100.00
Game Fish	52.5	17.4	118.0	61.1	50.5	23.4	73.77	31.84
Available Game Fish	34.7	11.5	66.9	34.7	31.2	14.5	44.27	19.11
Commercial Fish	47.1	15.6	23.9	12.4	56.4	26.2	42.47	18.33
Available Commercial Fish	33.4	11.1	20.6	10.7	39.9	18.5	31.30	13.51
Fish Under 5 Inches	103.9	34.4	54.5	28.2	26.7	12.4	61.70	26.64
Carnivorous Fish Over 5 Inches	63.5	21.0	35.2	18.2	42.9	19.9	47.20	20.38

TABLE 19

Results of 2.0" Mesh Trammel Nets Fished in August, October and November 1957 and February and March 1958 and Recorded as Average Number per Net Day. A Net Day is 100 Yards of Net Fished for 24 Hours.

	CADDO LAKE	CANE RIVER LAKE	CHICOT LAKE	LAKE PROVIDENCE
	Mean for 6 Net Days	Mean for 12 Net Days	Mean for 1 Net Day	Mean for 8 Net Days
Largemouth bass		0.17		0.63
Yellow bass	0.50			1.00
White bass	3.33		3.00	
White crappie	7.17		20.00	
Black crappie		0.17		0.50
Blue catfish	1.17		1.00	
Channel catfish	0.50			2.12
Yellow catfish	0.67	0.08		
Redear sunfish				0.25
Freshwater drum	4.83		2.00	0.12
Carp	0.17	2.33		
Yellow bullhead		3.83		
Black bullhead		0.83		
Shortnose gar	0.50	0.08		0.25
Longnose gar	0.33		1.00	0.12
Spotted gar	1.00			0.25
Lake chubsucker		4.83		
Carpsucker	6.83	0.25	6.00	
Spotted sucker		0.33		
Gizzard shad	34.33	13.83	29.00	5.38
River herring	0.17			
TOTAL NO.	61.50	26.73	62.00	10.62

Information from Lakes Caddo, Chicot, and Providence was provided from Dingell-Johnson Project F-5-R. Information for Cane River Lake was recorded by non-project personnel employed by the Louisiana Wild Life and Fisheries Commission.

TABLE 20

Results of 2.0" Mesh Trammel Nets Fished in August and October 1959 and Recorded as Average Number per Net Day. A Net Day is 100 Yards of Net Fished for 24 Hours.

	CADDO LAKE	CANE RIVER LAKE	LAKE PROVIDENCE
	Mean for 12 Net Days	Mean for 8 Net Days	Mean for 8 Net Da
Largemouth bass		1.25	0.38
Longear sunfish		0.12	
White crappie	0.92	0.12	
Black crappie	1.25		0.62
Warmouth	0.08		0.12
White bass	1.92		
Bigmouth buffalo			1.00
Black bullhead		2.62	
Brown bullhead		0.12	
Yellow bullhead		0.88	
Channel catfish	0.08	0.25	0.50
Blue catfish	0.17		
Carpsucker	0.50		
Spotted sucker	0.92		
Freshwater drum	0.08	0.25	0.25
Carp	0.25	2.00	0.25
Gizzard shad	0.33	6.38	0.50
Shortnose gar		0.12	0.25
Spotted gar		0.12	
Longnose gar	0.08		
Chain pickerel	0.17		
TOTAL NO.	6.75	14.23	3.87

Information recorded by non-project personnel employed by the Louisiana Wild Life and Fisheries Commission.

Lake Providence rotenone samples presented the second highest mean study standing crop production with a figure of 231.65 pounds per acre. Of this 107.66 pounds or 46.48% was composed of gizzard shad and threadfin shad. However, unlike Cane River Lake, this high shad production is countered by a high predaceous species for the three years. Bluegill were the most important game forage species and largemouth bass the most important game predaceous species.

All four lakes showed varying degrees of changes from year to year; both in the mean total standing crop production and in the species composition within that total. While it is understood the changes do occur annually, it is felt that a large portion of this variation could be attributed to the small numbers of rotenone samples collected. Even with this in mind, it is evident that the three types of lakes studied; that is, ox-bow, impoundment, and old river beds, have different trends in quantity of total production. The ox-bow, Lake Providence, and the old river, Cane River Lake, both of which are in fertile agricultural areas, have high standing crop production. The two impoundments, Caddo Lake and Chicot Lake, located in infertile wooded areas have low standing crop production.

A further breakdown may be made in the standing crop production between the two impoundments. Chicot Lake, which undergoes a severe water level draw-down annually, has a mean standing crop only slightly exceeding half of that of Caddo Lake. However, in composition the standing population of Chicot Lake is far more desirable with regard to species composition. The mean predator-prey relationship of 1:0.2 for Caddo Lake further presents the undesirability of the species composition of the population. Cane River Lake presents the opposite undesirable extreme with a mean predator-prey relationship of 1:10.2. If a Y/C ratio is calculated as described by Swingle (1950) for Cane River Lake substituting the length under five inches as the fish represented by Y instead of determining the size fish which could be eaten by the average adult predator, we arrive at a ratio of 10.2. Swingle (1950) described the desired figure to be between 1.0 and 3.0.

DISCUSSION

None of the lakes studied in this project were found to have chemical or physical characteristics which were prohibitive to aquatic life. Free carbon dioxide and dissolved oxygen were not noted in quantities or pH in ranges which could be considered lethal or restrictive. The alkalinity as found in the two impoundments was low and in the old river and ox-bow lakes it was high. This compares with the standing fish population production which was correspondingly low in the two former lakes and high in the two latter ones. Although in considering this comparison it must be remembered that the limiting effect of the annual water level draw-down in Chicot Lake is not fully known on the fish population standing crop. As for Caddo Lake, these results, compared with those of Moyle (1946) who found that lakes with total alkalinity less than 40 ppm, were low in fish population production.

Total phosphorus as determined was noted to be present in quantities inversely proportionate to nanno plankton organic material in Caddo Lake. This inverse ratio was also seen to a much lesser degree in Cane River Lake and Lake Providence. This was the only chemical compound found to correlate in any degree with plankton production.

Temperature presented a limiting effect in the development of a stratified condition in the summer in Cane River Lake, Chicot Lake, and Lake Providence. The extent of the effect of this stratification is not known for Cane River Lake as no dissolved oxygen determinations were conducted on the bottom during periods of temperature differences. No such determinations were made in Lake Providence either, but results from Lake Bruin, which is also a Mississippi River ox-bow lake of similar morphometry, were given by Geagan and Fuss (1959). These results showed the hypolimnion in July 1958 to have only 0.1 ppm oxygen in contrast to the surface content of 10.6 ppm oxygen. Since these two lakes are similar in morphometry and both exhibit the same type thermal stratification, it is assumed that the same depletion of dissolved oxygen occurrs in Lake Providence as in Lake Bruin. The benthos samples from Lake Providence further substantiate this assumption in that the standing crop during late July was composed primarily of organisms listed for oxygenless profundal regions, Welch (1952); these being Chaoborus sp., Tendipedidae larvae, and Sphaeriidae.

Chicot Lake exhibited a chemical stratification occurring in conjunction with the thermal stratification. Surface samples on July 24, 1958 at Series B contained 8.2 ppm dissolved oxygen and no free carbon dioxide and had a pH of 8.0. A bottom sample collected simultaneously at seven feet contained no dissolved oxygen according to the methods used, 45 ppm free carbon dioxide, and had a pH of 6.1. As previously stated Moore (1952) found that temporary upsets occurred in the stratification of Chicot Lake. Therefore, it would be difficult to evaluate the overall effect on aquatic organisms due to such a stratification.

The mean gravimetric plankton production as indicated followed the pattern established by the mean fish population standing crop production. Lake Providence and Cane River Lake were both higher in the mean standing crop production of both these factors and Caddo and Chicot Lakes were both correspondingly low.

The plankton counts for the larger zooplankters are considerably higher from the two lakes which undergo some form of fish population manipulation. In Chicot Lake there is the annual water level drawdown program and in Cane River Lake there has been conducted an annual selective poisoning operation for the removal of gizzard shad. Since the gizzard shad is a plankton feeder, it is not known if this production of large zooplankters is due to the depletion of the fish population in this segment or if it would develop regardlessly.

These organisms, that is, the Cladocera and the Eucopepoda, were utilized in Chicot Lake as food rather heavily by the bluegill. Of the 108 bluegill stomachs examined, the Eucopepoda occurred in 33 and the Cladocera in 38. The total number of the two groups found were 233 and 1039 respectively. Their utilization was much less in Cane River Lake.

Benthos standing crop production is difficult to use as an evaluation of the total production of a lake due to interspecies predation, fish predation, and natural seasonal fluctuation. Also, the life histories and habits of the groups involved are significant. For example those organisms which have deep burrowing habits and long life cycles, may be present in considerable quantities but are limited in their availability as food organisms. Hayne and Ball (1956) showed that in the presence of fish predation the total annual benthos production might exceed that produced in the absence of such predation by as much as 17 times, even though the standing crop was greater in the absence of fish.

Benthos sampling does, however, provide information as to the significance of this group of organisms as food of fish. Tables 21 through 27 illustrate the forage ratios for the fish samples from the four study lakes. In these tables the results are derived from a comparison of the benthos samples from the summer samples with the fish stomach analyses, these also being collected during the summer.

TABLE 21 A*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Redear (*Lepomis microlophus*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					CANE RIVER LAKE				
	Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae	0.10	0.18				0.10	0.16			
Nematoda	0.36	0.66	0.23	0.35	0.13					
Phylactolaemata										
Pulmatellina										
Lophopodidae										
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28	0.58	0.11	0.32	0.10	0.16	2.47	15.44	0.10
Oligochesta										
Plesiopora										
Tubificidae	4.01	7.34				24.78	39.78			
Prosopora										
Lumbriculidae	1.02	1.87				0.10	0.16			
Crustacea										
Ostracoda										
Podocopa								0.62		
Cladocera										
Eucopepoda			1.39			0.54	0.87	23.46	26.96	0.54
Amphipoda			0.11							
Talitridae	2.33	4.27	1.86	0.44	1.02	0.24	0.38	1.23	3.24	0.24
Gammeridae	0.36	0.66								
Decapoda										
Palaemonidae	0.10	0.18	0.11	0.61	0.06					
Arachnoidea										
Hydracarina	0.10	0.18	0.23	1.28	0.10					
Insecta								1.23		
Ephemeroptera										
Ephemeridae	5.64	10.33	31.32	3.03	5.64					
Baetidae										
Odonata										
Anisoptera	0.10	0.18								
Libellulidae			0.11			0.10	0.16			
Zygoptera										
Coenagrionidae	0.10	0.18				0.48	0.77	0.62	0.81	0.39
Cordulegasteridae										
Tricoptera	0.10	0.18						0.62		
Diptera										
Tendipedidae	12.30	22.53	27.14	1.21	12.30	2.40	3.85	65.43	16.99	2.40
Ceratopogonidae	0.10	0.18	0.23	1.28	0.10			1.23		
Culicidae										
Chaoborinae	2.24	4.10	0.70	0.17	0.38	33.36	53.55	1.85	0.03	1.00
Tabanidae	0.10	0.18								
Coleoptera										
Elmidae	0.10	0.18								
Haliplidae						0.10	0.16			
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46	13.92	0.47	7.56					
Eulamellibranchia										
Unionidae			0.58							
Gastropoda										
Prosobranchia										
Viviparidae	4.38	8.02	21.34	2.66	4.38					
Pulmonata										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			0.11					1.24		
TOTAL	54.59	99.97	99.96		31.99	62.30	100.00	100.00		4.67

* See Table B for Lakes Chicot and Providence.

TABLE 21 B*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Redear (*Lepomis microlophus*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CHICOT LAKE					LAKE PROVIDENCE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae										
Nematoda	0.10	0.12				0.10	0.07	0.57	8.14	0.10
Phylactolaemata										
Pulmatellina										
Lophopodidae	0.10	0.12								
Hirudinea										
Rhynchobdellida										
Glossiphoniidae			0.33			0.84	0.61			
Oligocheata										
Plesiopora										
Tubificidae	8.34	9.91				78.78	59.68			
Prosopora										
Lumbriculidae						0.90	0.65			
Crustacea										
Ostracoda										
Podocopa			0.33				0.57			
Cladocera			5.79							
Eucopepoda			9.29				1.15			
Amphipoda										
Talitridae	0.30	0.36	3.82	10.61	0.30	4.92	3.56	2.30	0.65	3.20
Gammeridae										
Decapoda										
Palaemonidae								0.57		
Arachnoidea										
Hydracarina										
Insecta			0.22							
Ephemeroptera										
Ephemeridae						0.10	0.07			
Baetidae			0.11							
Odonata			0.11							
Anisoptera								0.57		
Libellulidae			0.22							
Zygoptera			0.11							
Coenagrionidae										
Cordulegasteridae			0.44							
Tricoptera								0.57		
Diptera										
Tendipedidae	3.90	4.64	74.21	15.99	3.90	1.56	1.13	82.76	73.24	1.56
Ceratopogonidae	0.30	0.36				0.30	0.22			
Culicidae										
Chaoborinae	68.20	81.07	5.03	0.06	4.09	39.90	28.86	1.72	0.06	2.39
Tabanidae										
Coleoptera	0.10	0.12						0.57		
Elmidae										
Haliplidae										
Pelecypoda										
Heterodonta										
Sphaeriidae	2.78	3.30				10.86	7.85	5.75	0.73	7.93
Eulamellibranchia										
Unionidae										
Gastropoda										
Prosobranchia										
Viviparidae								2.87		
Pulmonata										
Lymnaeidae										
Vertebrata										
Pisces										
TOTAL	84.12	100.00	100.01		8.29	138.26	100.00	99.97		15.18

* See Table 21 A for Caddo and Cane River Lakes

TABLE 22 A*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Bluegill (*Lepomis macrochirus*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					CANE RIVER LAKE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae	0.10	0.18				0.10	0.16			
Nematoda	0.36	0.66	18.86	28.58	0.36					
Phylactolaemata										
Pulmatellina										
Lophopodidae										
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28	0.18	0.03	0.09	0.10	0.16			
Oligocheata								0.08		
Plesiopora										
Tubificidae	4.01	7.34				24.78	39.78			
Prosopora										
Lumbriculidae	1.02	1.87				0.10	0.16			
Crustacea										
Ostracoda										
Podocopa			5.16					31.59		
Cladocera			2.14					0.48		
Eucopepoda			2.14			0.54	0.87	0.16	0.18	0.10
Isoptera										
Sphaeromidae										
Asellidae										
Amphipoda			0.18							
Talitridae	2.33	4.27	6.05	1.42	2.33	0.24	0.38	2.06	5.42	0.24
Gammeridae	0.36	0.66								
Decapoda										
Cambarina								0.08		
Palaemonidae	0.10	0.18	0.36	2.00	0.10					
Arachnoidea										
Hydracarina	0.16	0.18	0.53	2.94	0.10			0.16		
Insecta			0.18					0.71		
Plecoptera										
Ephemeroptera										
Ephemeridae	5.64	10.33	38.61	3.74	5.64					
Baetidae			0.18					0.32		
Odonata										
Anisoptera	0.10	0.18								
Aeschinidae										
Libellulidae			0.18			0.10	0.16			
Zygoptera										
Coenagrionidae	0.10	0.18				0.48	0.77			
Gomphidae										
Hemiptera								0.08		
Tricoptera	0.10	0.18	3.38	18.78	0.10			0.16		
Diptera										
Tendipedidae	12.30	22.53	20.28	0.90	11.97	2.40	3.85	60.48	15.71	2.40
Ceratopogonidae	0.10	0.18						0.16		
Culicidae										
Chaoborinae	2.24	4.10				33.36	53.55	2.85	0.05	1.67
Tabanidae	0.10	0.18								
Coleoptera								0.08		
Gyrinidae								0.08		
Elmidae	0.10	0.18						0.16		
Dytiscidae										
Halpidae						0.10	0.16			
Chrysomelidae										
Formicoidea										

(continued)

TABLE 22 A* (continued)

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Bluegill (Lepomis macrochirus) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					CANE RIVER LAKE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46	1.24	0.04	0.64			0.08		
Eulamellibranchia										
Unionidae	0.17	0.31								
Gastropoda										
Prosobranchia										
Viviparidae	4.38	8.02	0.18	0.02	0.09					
Pulmonata										
Physidae										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			0.18					0.16		
TOTAL	54.59	99.97	100.01		21.42	62.30	100.00	100.01		4.41

* See Table 22 B for Lakes Chicot and Providence.

TABLE 22 B*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Bluegill (*Lepomis macrochirus*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CHICOT LAKE					LAKE PROVIDENCE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabodocoelida										
Dalyellidae										
Nematoda	0.10	0.12	0.06	0.50	0.05	0.10	0.07			
Phylactolaemata										
Pulmatellina										
Lophopodidae	0.10	0.12								
Hirudinea										
Rhynchobdellida										
Glossiphoniidae			0.11			0.84	0.61			
Oligocheata										
Plesiopora										
Tubificidae	8.34	9.91				78.78	56.98			
Prosopora										
Lumbriculidae						0.90	0.65			
Crustacea										
Ostracoda										
Podocopa			6.66					8.56		
Cladocera			22.57					0.23		
Eucopepoda			5.06					0.07		
Isoptera										
Sphaeromidae			1.17							
Asellidae			0.20							
Amphipoda										
Talitridae	0.30	0.36	21.09	58.58	0.30	4.92	3.56	3.80	1.07	4.92
Gammeridae										
Decapoda										
Cambarina										
Palaemonidae			0.48					0.07		
Arachnoidea										
Hydracarina			0.82					0.02		
Insecta								0.16		
Plecoptera			0.02					0.02		
Ephemeroptera										
Ephemeridae			0.02			0.10	0.07	0.38	5.43	0.10
Baetidae								0.21		
Odonata								0.05		
Anisoptera			0.02							
Aeschinidae			0.02							
Libellulidae			1.30					0.50		
Zygoptera			0.28							
Coenagrionidae			0.06							
Gomphidae			0.78					0.20		
Hemiptera										
Tricoptera			0.63					0.05		
Diptera										
Tendipedidae	3.90	4.64	35.58	7.67	3.90	1.56	1.13	85.50	75.66	1.56
Ceratopogonidae	0.30	0.36	0.20	0.56	0.17	0.30	0.22	0.16	0.73	0.22
Culicidae										
Chaoborinae	68.20	81.07	1.02	0.01	0.68	39.90	28.86	0.09	**	0.12
Tabanidae										
Coleoptera	0.10	0.12	0.06	0.50	0.05			0.02		
Gyrinidae			0.02							
Elmidae										
Dytiscidae			0.04							
Halpidae										
Chrysomelidae								0.02		
Formicoidea			0.02							

(continued)

TABLE 22 B* (continued)

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Bluegill (Lepomis macrochirus) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CHICOT LAKE					LAKE PROVIDENCE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Pelecypoda										
Heterodonta										
Sphaeriidae	2.78	3.30	0.54	0.16	0.44	10.86	7.85	0.02	**	0.02
Eulamellibranchia										
Unionidae										
Gastropoda										
Prosobranchia										
Viviparidae			0.02							
Pulmonata										
Physidae			0.02							
Lymnaeidae										
Vertebrata										
Pisces			0.66					0.58		
TOTAL	84.12	100.00	99.02		5.59	138.26	100.00	100.08		6.94

* See Table 22 A for Caddo and Cane River Lakes.

** Trace

TABLE 23 A*

* See Table 23 B for Lakes Chicot and Providence.

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Largemouth Bass (*Micropterus salmoides*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					CANE RIVER LAKE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae	0.10	0.18				0.10	0.16			
Nematoda	0.36	0.66	2.86	4.33	0.36					
Phylactolaemata										
Pulmatellina										
Lophopodidae										
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28	11.43	2.16	2.88	0.10	0.16			
Oligocheata										
Plesiopora										
Tubificidae	4.01	7.34				24.78	39.78			
Prosopora										
Lumbriculidae	1.02	1.87				0.10	0.16			
Crustacea										
Ostracoda										
Podocopa			5.71							
Cladocera										
Eucopepoda						0.54	0.87			
Amphipoda										
Talitridae	2.33	4.27				0.24	0.38			
Gammeridae	0.36	0.66								
Decapoda										
Cambarina			2.86							
Palaemonidae	0.10	0.18								
Arachnoidea										
Hydracarina	0.10	0.18								
Insecta										
Ephemeroptera										
Ephemeridae	5.64	10.33								
Baetidae			2.86							
Odonata										
Anisoptera	0.10	0.18								
Libellulidae						0.10	0.16			
Zygoptera										
Coenagrionidae	0.10	0.18				0.48	0.77			
Tricoptera	0.10	0.18								
Diptera										
Tendipedidae	12.30	22.53	5.71	0.25	3.08	2.40	3.85	1.45	0.38	0.91
Ceratopogonidae	0.10	0.18								
Culicidae										
Chaoborinae	2.24	4.10				33.36	53.55			
Tabanidae	0.10	0.18								
Coleoptera										
Elmidae	0.10	0.18								
Dytiscidae						0.10	0.16			
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46								
Eulamellibranchia										
Unionidae	0.17	0.31								
Gastropoda										
Prosobranchia										
Vivipariidae	4.38	8.02								
Pulmonata										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			68.57					98.60		
TOTAL	54.59	99.97	100.00		6.32	62.30	100.00	100.05		0.91

TABLE 23 B*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Largemouth Bass (*Micropterus salmoides*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CHICOT LAKE					LAKE PROVIDENCE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabodocoelida										
Dalyellidae										
Nematoda	0.10	0.12	3.75	31.25	0.10	0.10	0.07	21.43	306.14	0.10
Phylactolaemata										
Pulmatellina										
Lophopodidae	0.10	0.12								
Hirudinea										
Rhynchobdellida										
Glossiphoniidae			2.50			0.84	0.61			
Oligocheata										
Plesiopora										
Tubificidae	8.34	9.91				78.78	56.98			
Prosopora										
Lumbriculidae						0.90	0.65			
Crustacea										
Ostracoda										
Podocopa			2.50							
Cladocera			5.00							
Eucopepoda			11.25							
Amphipoda										
Talitridae	0.30	0.36				4.92	3.56			
Gammeridae										
Decapoda										
Cambarina								2.38		
Palaemonidae										
Arachnoidea										
Hydracarina										
Insecta								2.38		
Ephemeroptera										
Ephemeridae						0.10	0.07			
Baetidae										
Odonata										
Anisoptera										
Libellulidae										
Zygoptera										
Coenagrionidae										
Tricoptera										
Diptera										
Tendipedidae	3.90	4.64	13.75	2.96	3.90	1.56	1.13	2.38	2.11	1.56
Ceratopogonidae	0.30	0.36				0.30	0.22			
Culicidae										
Chaoborinae	68.20	81.07				39.90	28.86	2.38	0.08	3.19
Tabanidae										
Coleoptera	0.10	0.12								
Elmidae										
Dytiscidae										
Pelecypoda										
Heterodonta										
Sphaeriidae	2.78	3.30				10.86	7.85			
Eulamellibranchia										
Unionidae										
Gastropoda										
Prosobranchia										
Viviparidae										
Pulmonata										
Lymnaeidae										
Vertebrata										
Pisces			61.25					69.04		
TOTAL	84.12	100.00	100.00		4.00	138.26	100.00	99.99		4.85

* See Table 23 A for Caddo and Cane River Lakes.

TABLE 24

Forage Ratios and Food Grade Values for Bottom Organisms Occurring in Black Crappie (*Pomoxis nigramacrulatus*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					CHICOT LAKE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabodocoelida										
Dalyellidae	0.10	0.18								
Nematoda	0.36	0.66				0.10	0.12	0.08	0.67	0.07
Phylactolaemata										
Pulmatellina										
Lophopodidae						0.10	0.12			
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28								
Oligocheata										
Plesiopora										
Tubificidae	4.01	7.34				8.34	9.91			
Prosopora										
Lumbriculidae	1.02	1.87								
Crustacea										
Ostracoda										
Podocopa								0.80		
Cladocera								3.72		
Eucopepoda								17.02		
Amphipoda										
Talitridae	2.33	4.27	7.27	1.70	2.33	0.30	0.36	5.21	14.47	0.30
Gammaridae	0.36	0.66								
Decapoda										
Palaemonidae	0.10	0.18						0.64		
Arachnoidea										
Hydracarina	0.10	0.18						0.32		
Insecta										
Plecoptera								6.05		
Ephemeroptera										
Ephemeridae	5.64	10.33	61.82	5.98	5.64			0.08		
Baetidae			12.73					0.12		
Odonata								0.08		
Anisoptera	0.10	0.18								
Libellulidae										
Zygoptera								0.08		
Coenagrionidae	0.10	0.18								
Tricoptera	0.10	0.18								
Diptera										
Tendipedidae	12.30	22.53	1.82	0.08	0.10	3.90	4.64	24.39	5.26	3.90
Ceratopogonidae	0.10	0.18				0.30	0.36	0.04	0.11	0.03
Culicidae										
Chaoborinae	2.24	4.10				68.20	81.07	40.21	0.50	34.10
Tabanidae	0.10	0.18								
Coleoptera						0.10	0.12			
Elmidae	0.10	0.18								
Curculionidae								0.04		
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46				2.78	3.30			
Eulamellibranchia										
Unionidae	0.17	0.31								
Gastropoda										
Prosobranchia										
Viviparidae	4.38	8.02								
Pulmonata										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			16.36					1.20		
TOTAL	54.59	99.97	100.00		8.07	84.12	100.00	100.08		38.40

The results shown are the mean of the 1958 and 1959 sampling.

Food preferences were found to vary for each species of fish sampled from lake to lake. However, within this variation certain groups of organisms were found to be utilized consistently in all lakes by most species of fish. Among the most significant of these were the Tendipedidae and the Talitridae. In considering the Talitridae though, the forage ratios present are misleading in that this group of organisms does not present itself favorably for collection in benthos sampling procedures. As for the variation among species of fish for food preferences, this is seen even in species which resemble each other as closely as the bluegill and the redear. The redear which is more abundant in Caddo Lake (10.02% of the mean standing fish population) utilizes the Viviparidae with a forage ratio of 2.66 while the bluegill (1.51% of the mean standing fish population) utilizes this group only slightly (forage ratio of 0.02).

From this it could be assumed that the redear, constitutes a larger percentage of fish population of Caddo Lake because of its ability to utilize or its preference for this food group which is abundant in this particular lake. To further substantiate this assumption are the results shown in Table 27 which presents the forage ratios for the freshwater drum. This species of fish composes 36.52% of the mean standing crop from Caddo Lake for the three years. In these results, it is seen that the freshwater drum utilized the Ephemeridae and the Tendipedidae entensively. Both of these groups are among the more productive from Caddo Lake and both are burrowing forms which apparently the drum is capable of obtaining. A further projection of this is the abundance of shad, which are plankton feeders, in Cane River Lake which also had the greatest plankton production.

The food grade values given in Tables 21-A through 27 were derived using Hess' method as described by Surber (1940). These food grade values for Caddo Lake were higher than those from the other three lakes for all species of fish except the black crappie. However, when the results, as given in Tables 21 through 27 are examined, it is evident that the total number of kinds of organisms occurring in both the benthos and stomach samples is greater in Caddo Lake than in the other three lakes. The largest part of this difference being due to the lesser number of kinds of organisms collected in the benthos samples from the other three lakes. This greater variety of organisms for Caddo Lake benthos was also noted in the results of the benthos samples throughout the study. These factors, therefore, give rise to a question to the value of the benthos samples collected in the other lakes as a true measure of this segment of the lakes' biological production. This is especially true in the summer, when the samples used for the determination of the forage ratios and the food grade values

TABLE 25 A*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Warmouth (Chaenobryttus gulosus) Stomachs Collected during the Summers of 1958 and 1959.

	CADDO LAKE					CHICOT LAKE				
ORGANISMS	Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae	0.10	0.18								
Nematoda	0.36	0.66				0.10	0.12	3.94	32.83	0.10
Phylactolaemata										
Pulmatellina										
Lophopodidae						0.10	0.12			
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28						1.51		
Oligocheata										
Plesiopora										
Tubificidae	4.01	7.34				8.34	9.91			
Prosopora										
Lumbriculidae	1.02	1.87								
Crustacea										
Ostracoda										
Podocopa								0.34		
Cladocera								0.67		
Eucopepoda								1.09		
Amphipoda										
Talitridae	2.33	4.27	27.73	6.49	2.33	0.30	0.36	1.09	3.03	0.30
Gammeridae	0.36	0.66								
Decapoda										
Palaemonidae	0.10	0.18						0.28		
Arachnoidea										
Hydracarina	0.10	0.18						5.20		
Insecta								0.33		
Ephemeroptera										
Ephemeridae	5.64	10.33	13.64	1.32	5.64			0.08		
Baetidae								0.25		
Odonata										
Anisoptera	0.10	0.18								
Zygoptera								1.67		
Coenagrionidae	0.10	0.18								
Cordulegasteridae								0.84		
Tricoptera	0.10	0.18								
Diptera										
Tendipedidae	12.30	22.53	13.64	0.61	7.50	3.90	4.64	80.30	17.31	3.90
Ceratopogonidae	0.10	0.18				0.30	0.36			
Culicidae										
Chaoborinae	2.24	4.10				68.20	81.07	2.35	0.03	2.05
Tabanidae	0.10	0.18								
Coleoptera						0.10	0.12			
Elmidae	0.10	0.18						0.08		
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46				2.78	3.30			
Eulamellibranchia										
Unionidae	0.17	0.31								
Gastropoda										
Prosobranchia										
Viviparidae	4.38	8.02						0.08		
Pulmonata										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			49.99					1.85		
TOTAL	54.59	99.97	100.00		15.47	84.12	100.00	101.92		6.35

* See Table 25 B for Lake Providence.

TABLE 25 B*

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Warmouth (Chaenobryttus gulosus) Stomachs Collected during the summers of 1958 and 1959.

LAKE PROVIDENCE

ORGANISMS	Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria					
Rhabodocoelida					
Dalyellidae					
Nematoda	0.10	0.07			
Phylactolaemata					
Pulmatellina					
Lophopodidae					
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	0.84	0.61			
Oligocheata					
Plesiopora					
Tubificidae	78.78	56.98	5.77	0.10	5.70
Prosopora					
Lumbriculidae	0.90	0.65			
Crustacea					
Ostracoda					
Podocopa					
Cladocera					
Eucopepoda					
Amphipoda					
Talitridae	4.92	3.56	5.77	1.62	4.92
Gammeridae					
Decapoda					
Palaemonidae			3.85		
Arachnoidea					
Hydracarina					
Insecta					
Ephemeroptera					
Ephemeridae	0.10	0.07			
Baetidae			1.92		
Odonata					
Anisoptera					
Zygoptera					
Coenagrionidae			1.92		
Cordulegasteridae					
Tricoptera			34.61		
Diptera					
Tendipedidae	1.56	1.13	21.15	18.72	1.56
Ceratopogonidae	0.30	0.22			
Culicidae					
Chaoborinae	39.90	28.86			
Tabanidae					
Coleoptera					
Elmidae					
Pelecypoda					
Heterodonta					
Sphaeriidae	10.86	7.85			
Eulamellibranchia					
Unionidae					
Gastropoda					
Prosobranchia					
Vivipariidae					
Pulmonata					
Lymnaeidae					
Vertebrata					
Pisces			25.01		
TOTAL	138.26	100.00	100.00		12.18

* See Table A for Caddo and Cane River Lakes.

TABLE 26

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Yellow Bass (Roccus mississipiensis) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE					LAKE PROVIDENCE				
	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value	Avg. No. Organisms per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria										
Rhabdocoelida										
Dalyellidae	0.10	0.18								
Nematoda	0.36	0.66				0.10	0.07			
Hirudinea										
Rhynchobdellida										
Glossiphoniidae	2.88	5.28	0.55	0.10	0.29	0.84	0.61			
Oligocheata										
Plesiopora										
Tubificidae	4.01	7.34				78.78	56.98			
Prosopora										
Lumbriculidae	1.02	1.87				0.90	0.65			
Crustacea										
Amphipoda										
Talitridae	2.33	4.27				4.92	3.56			
Gammeridae	0.36	0.66								
Decapoda										
Palaemonidae	0.10	0.18	1.38	7.67	0.10					
Arachnoidea										
Hydracarina	0.10	0.18								
Insecta								21.88		
Ephemeroptera										
Ephemeridae	5.64	10.33	56.63	5.48	5.64	0.10	0.07			
Odonata										
Anisoptera	0.10	0.18								
Libellulidae			0.28							
Zygoptera										
Coenagrionidae	0.10	0.18								
Tricoptera	0.10	0.18								
Diptera										
Tendipedidae	12.30	22.53	2.76	0.12	1.48	1.56	1.13	18.75	16.59	1.56
Ceratopogonidae	0.10	0.18				0.30	0.22			
Culicidae										
Chaoborinae	2.24	4.10	0.83	0.20	0.45	39.90	28.86			
Tabanidae	0.10	0.18								
Coleoptera										
Elmidae	0.10	0.18								
Pelecypoda										
Heterodonta										
Sphaeriidae	16.08	29.46				10.86	7.85			
Eulamellibranchia										
Unionidae	0.17	0.31								
Gastropoda										
Prosobranchia										
Viviparidae	4.38	8.02								
Pulmonata										
Lymnaeidae	1.92	3.52								
Vertebrata										
Pisces			37.57					59.37		
TOTAL	54.59	99.97	100.00		7.96	138.26	100.00	100.00		1.56

TABLE 27

Forage Ratios and Food Grade Value for Bottom Organisms Occurring in Drum (*Aplodinotus grunniens*) Stomachs Collected during the Summers of 1958 and 1959.

ORGANISMS	CADDO LAKE Avg. No. Organism per sq. ft.	Percent of Total	Percent in Stomach	Forage Ratio	Food Grade Value
Turbellaria					
Rhabodocoelida					
Dalyellidae	0.10	0.18			
Nematoda	0.36	0.66			
Hirudinea					
Rhynchobdellida					
Glossiphoniidae	2.88	5.28			
Oligocheata					
Plesiopora					
Tubificidae	4.01	7.34			
Prosopora					
Lumbriculidae	1.02	1.87			
Crustacea					
Amphipoda					
Talitridae	2.33	4.27			
Gammeridae	0.36	0.66			
Decapoda					
Palaemonidae	0.10	0.18			
Arachnoidea					
Hydracarina	0.10	0.18			
Insecta					
Ephemeroptera					
Ephemeridae	5.64	10.33	59.68	5.78	5.64
Odonata					
Anisoptera	0.10	0.18			
Zygoptera					
Coenagrionidae	0.10	0.18			
Tricoptera	0.10	0.18			
Diptera					
Tendipedidae	12.30	22.53	24.19	1.07	12.30
Ceratopogonidae	0.10	0.18	3.22	17.89	0.10
Culicidae					
Chaoborinae	2.24	4.10			
Tabanidae	0.10	0.18			
Coleoptera					
Elmidae	0.10	0.18			
Pelecypoda					
Heterodonta					
Sphaeriidae	16.08	29.46	1.61	0.05	0.80
Eulamellibranchia					
Unionidae	0.17	0.31			
Gastropoda					
Prosobranchia					
Viviparidae	4.38	8.02			
Pulmonata					
Lymnaeidae	1.92	3.52			
Vertebrata					
Pisces			11.28		
TOTAL	54.59	99.97	99.98		18.84

were collected. Of particular interest is whether the thermal stratification which was noted each summer in the lakes other than Caddo Lake may have developed zones of concentration of these organisms. Their presence in these lakes is undeniable inasmuch as they were found being utilized as fish food.

CONCLUSIONS

1. No chemical or physical characteristics were observed which were lethal to the aquatic community present in the lakes studied. Thermal stratification was observed which could be responsible for the redistribution of aquatic organisms in Cane River Lake, Chicot Lake, and Lake Providence.

2. Laboratory analyses for available phosphates, total phosphorous, ammonia nitrogen, organic nitrogen, nitrite nitrogen, and nitrate nitrogen were inconclusive. The only correlation found was an inverse ratio of the total phosphorous to the nanno plankton organic material.

3. Benthos production as indicated by the standing crop is not indicative of the standing crop production of the fish population, although it is of value in indicating fish food preferences and apparent abundance of species according to this preference and the ability of the fish to utilize those organisms which are present.

4. Adequate abundance of the young of the year of the game species of fish occurred throughout the study.

5. The total alkalinity and the gravimetric results of the total plankton corresponded directly with the standing crop fish production. These were found to be greatest in the ox-bow, Lake Providence, and the old river, Cane River Lake. The two impoundments were much lower in the standing crop fish production.

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